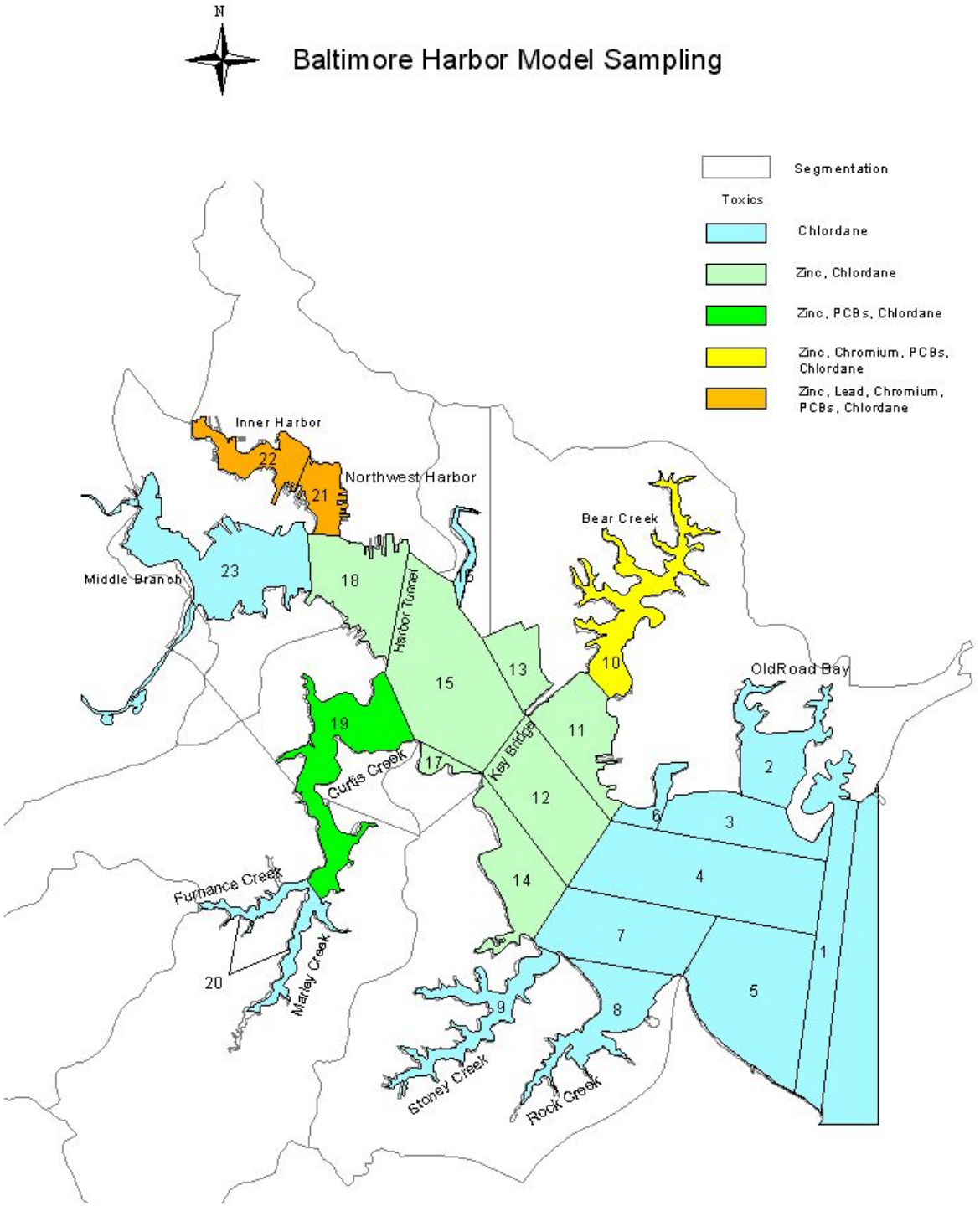
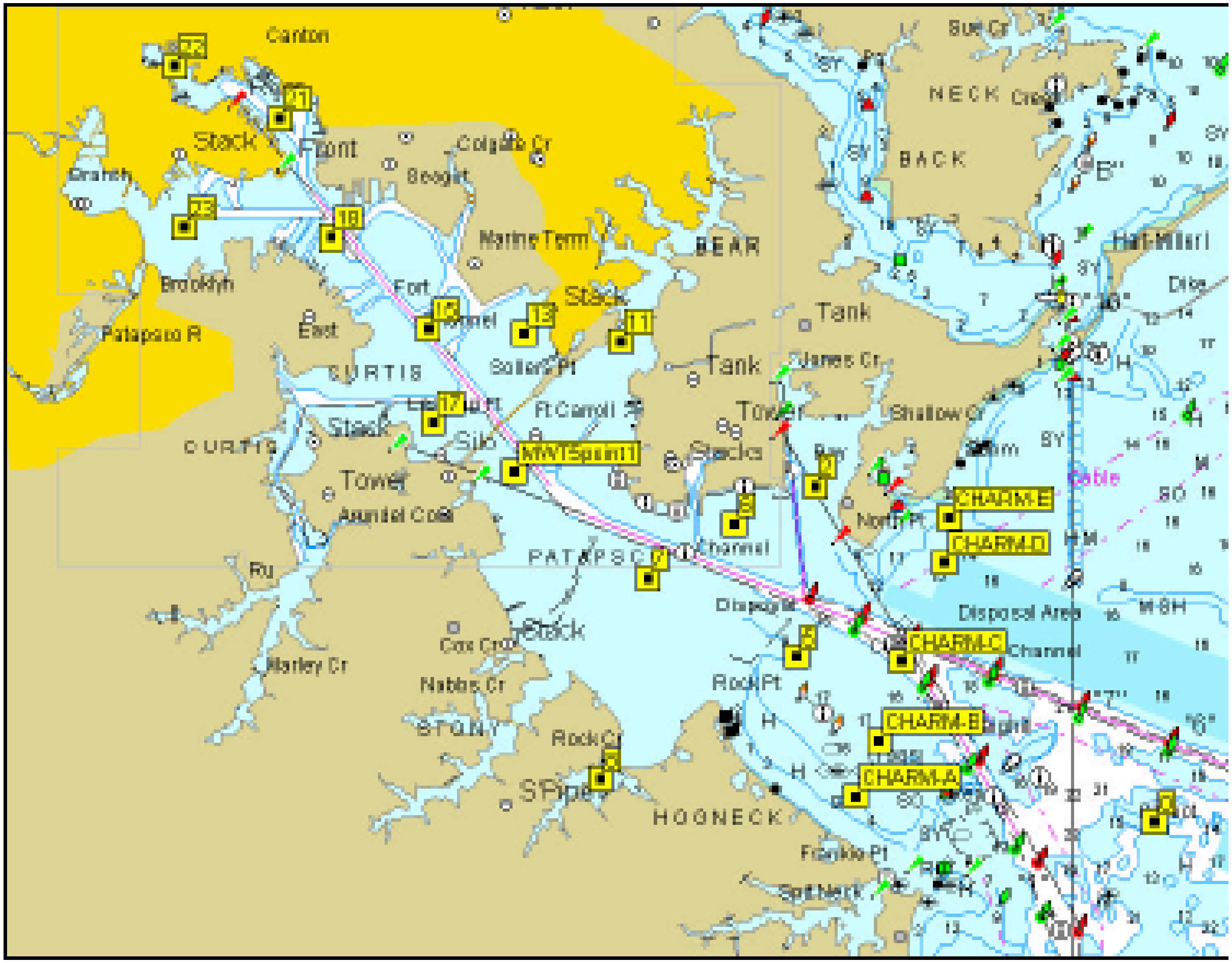
Outline

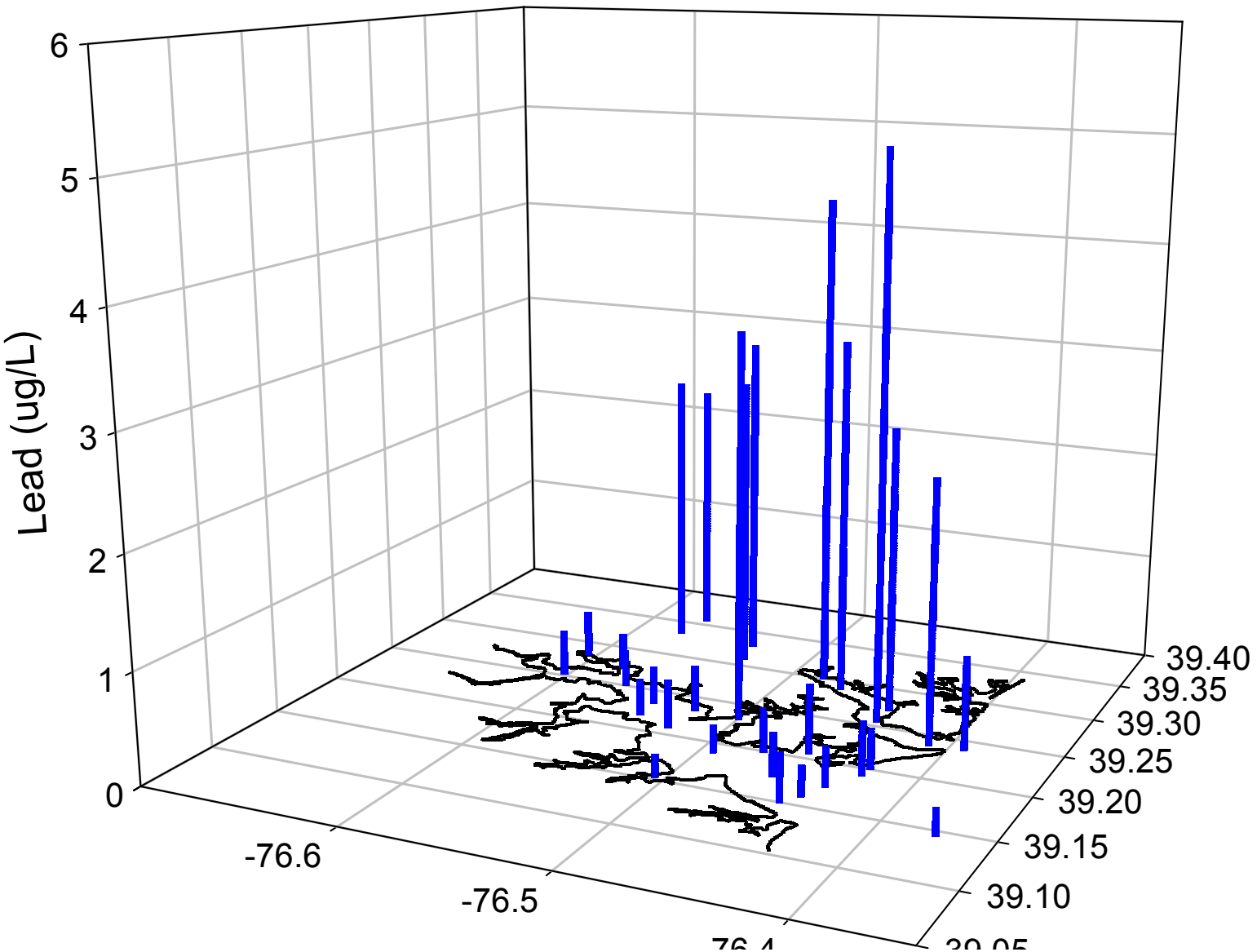
- Update of model development
- Review of recent field data
- Response of model to loadings
- Overall sense of metals behavior
- Next steps

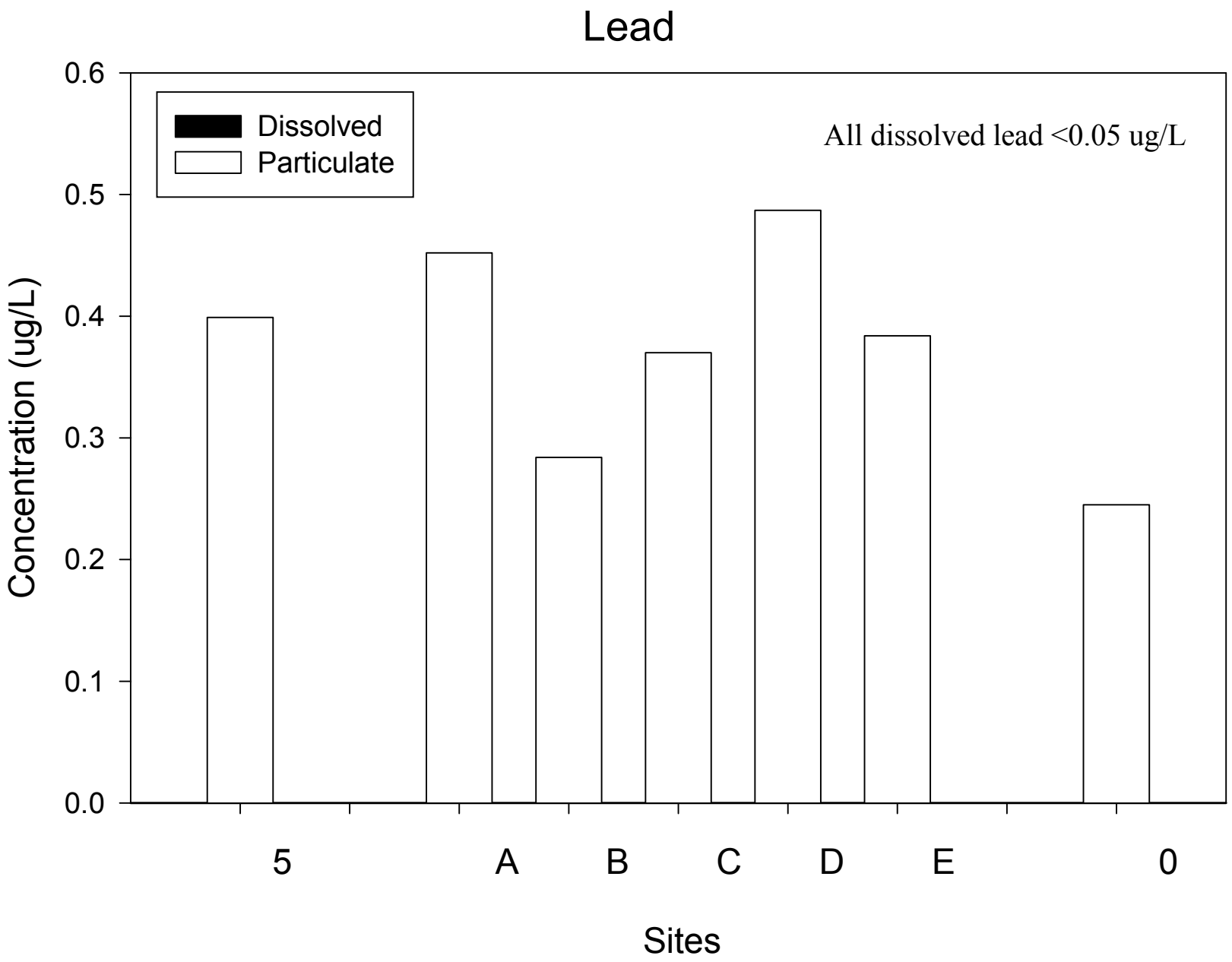
Zinc
Lead
Chromium

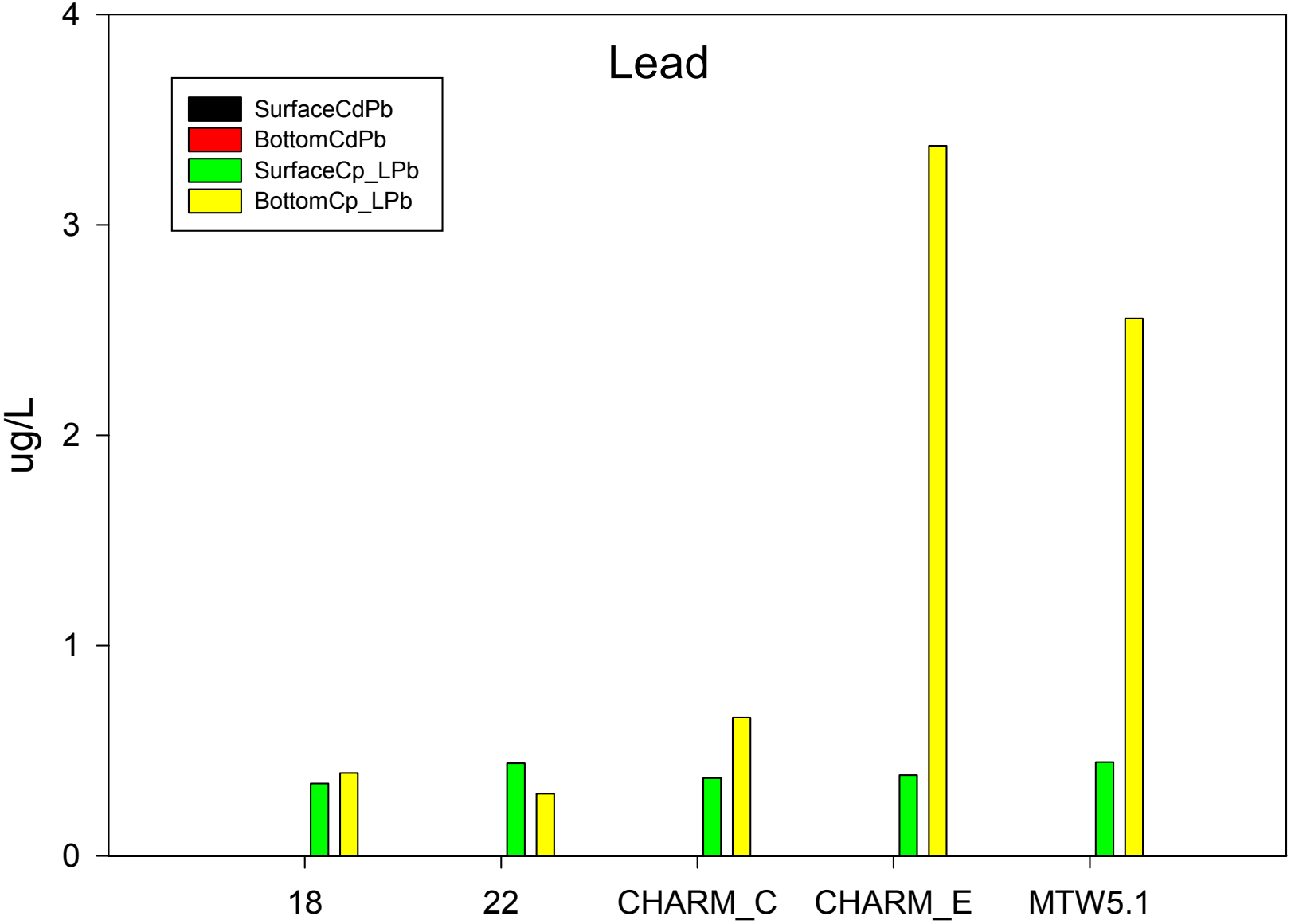
PCBs
Chlordanes

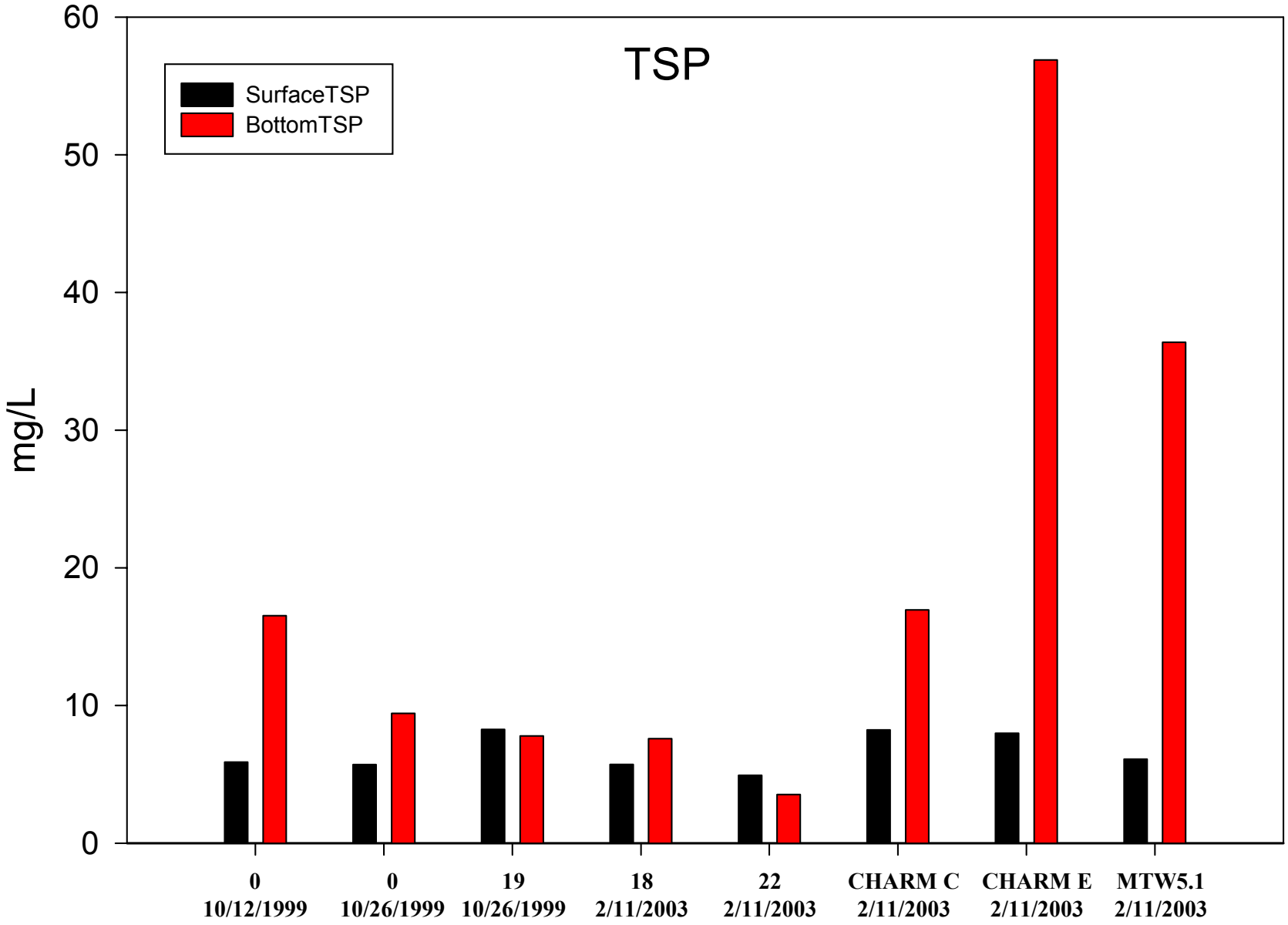


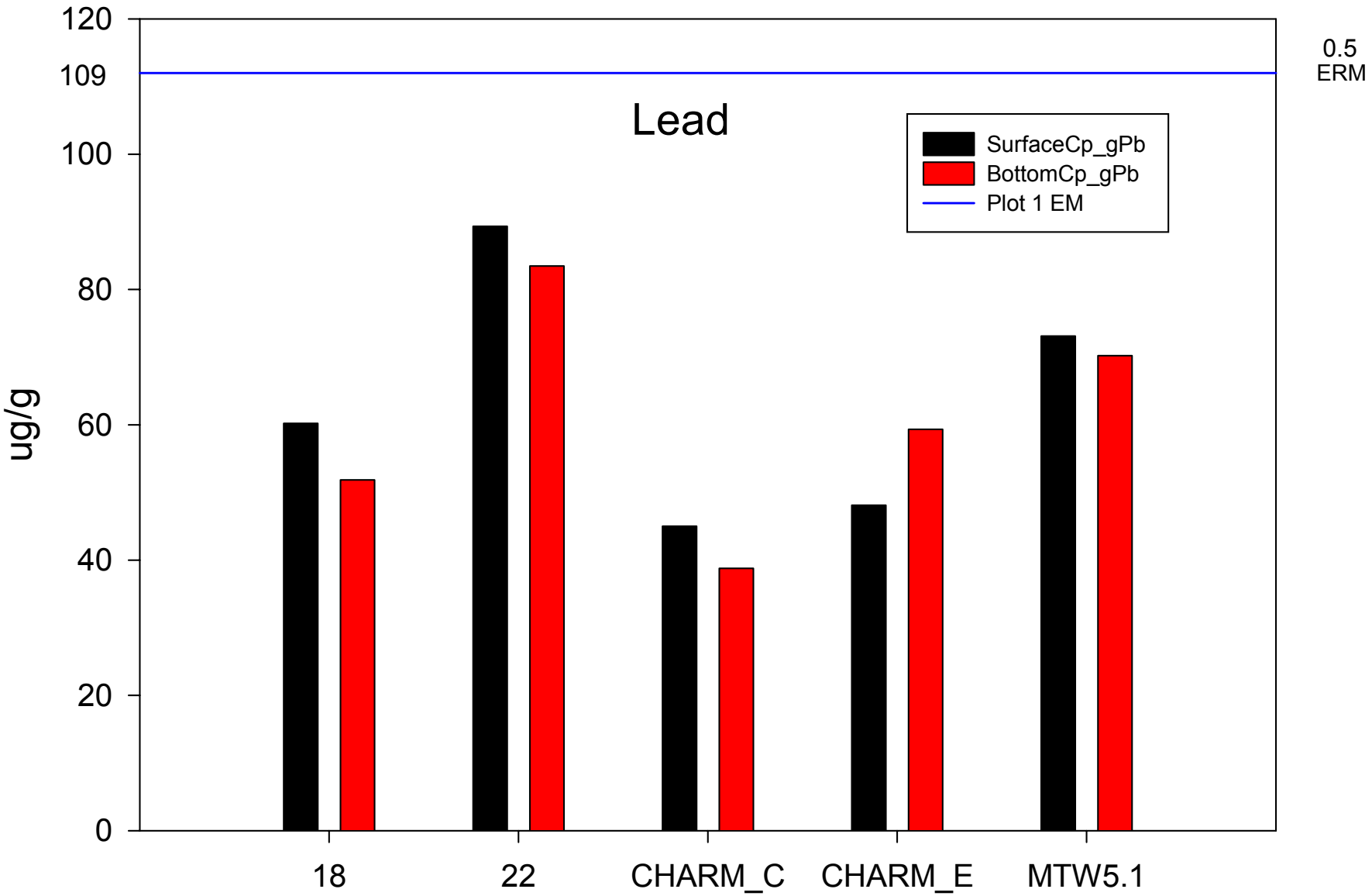

Canton
Stack
Fort
Colgate Cr
Seagirt
Brooklyn
Patapsco R
Marine Term
BEAR
Stack
Fort
Carroll
East
CURTIS
Sollers Pt
Ft Carroll
Tank
Tank
James Cr
Tower
Stacks
Stack
Silo
MWTSpoint1
CURTIS
Tower
Arundel Cove
PATAPSCO
Channel
Stack
Cox Cr
Marley Cr
Nabbs Cr
Rock Cr
STONY
Rock Pt
HOGNECK
Fort Pt
Sue Cr
NECK
BACK
Shallow Cr
North Pt
CHARM-E
CHARM-D
CHARM-C
CHARM-B
CHARM-A
Disposal Area
Channel
Cable
22
21
23
18
15
13
11
17

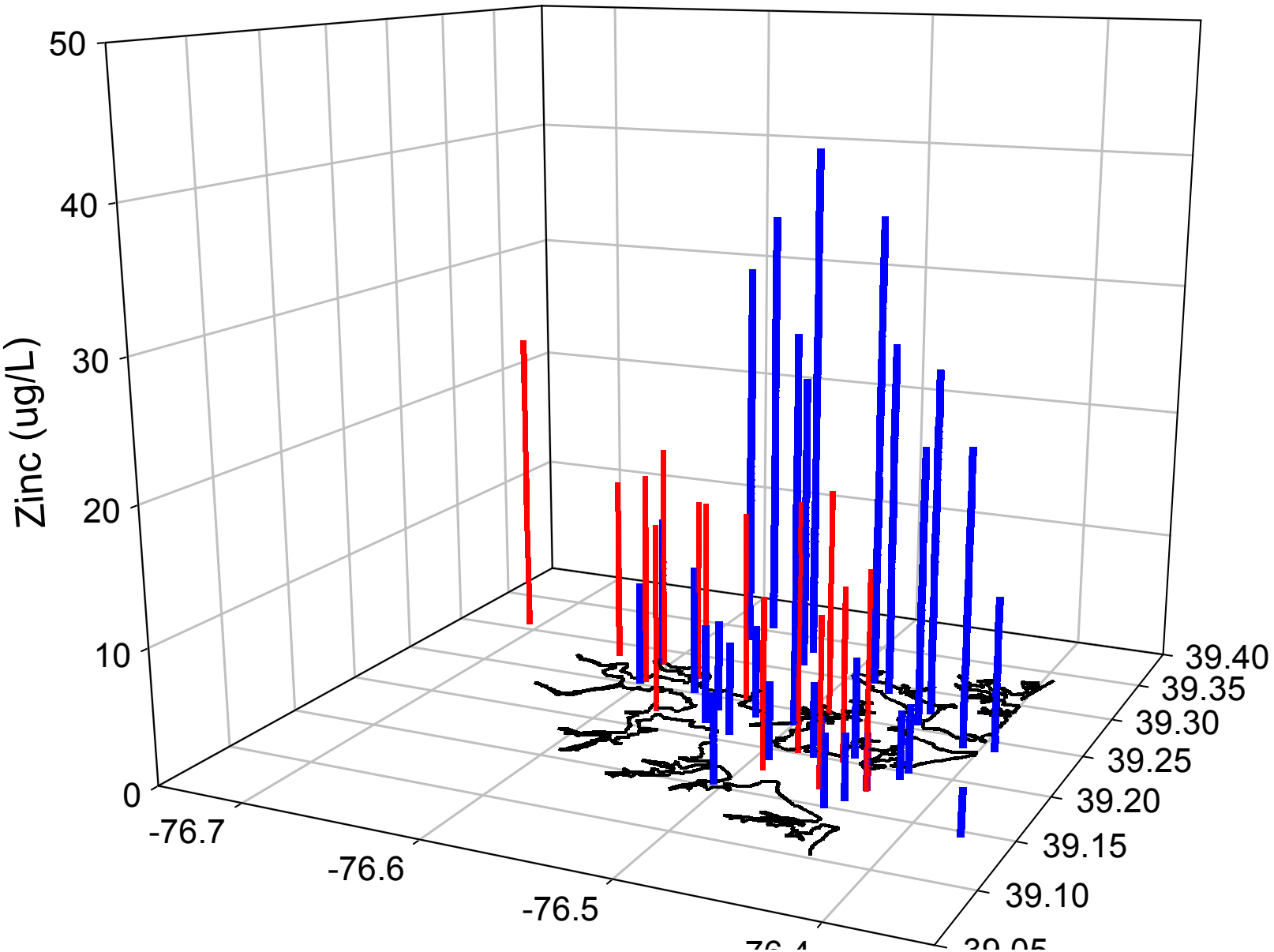

Lead (ug/L)
6
5
4
3
2
1
0
-76.6
-76.5
39.40
39.35
39.30
39.25
39.20
39.15
39.10

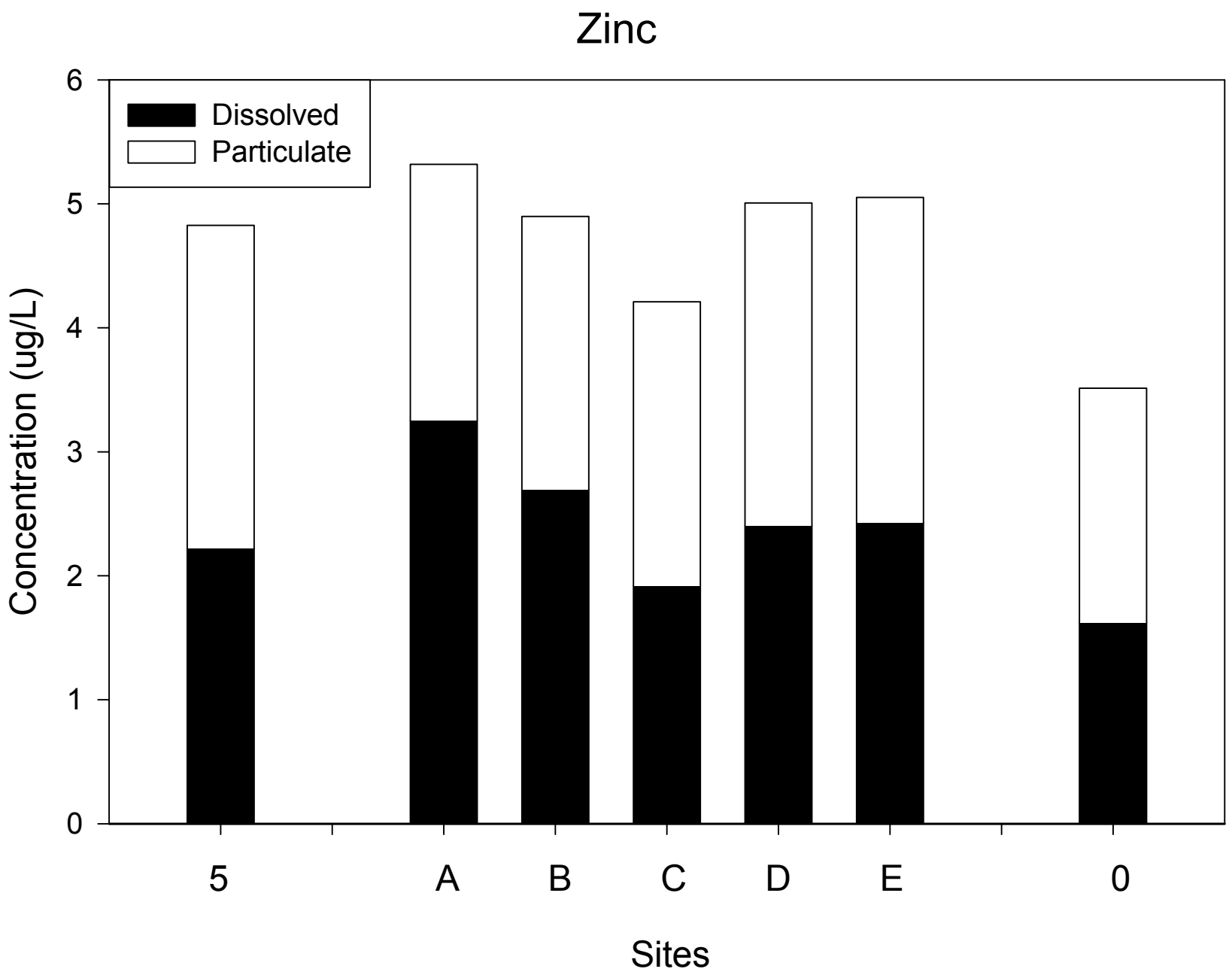

Lead
Dissolved
Particulate
All dissolved lead <0.05 ug/L
Concentration (ug/L)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
5
A
B
C
D
E
0
Sites

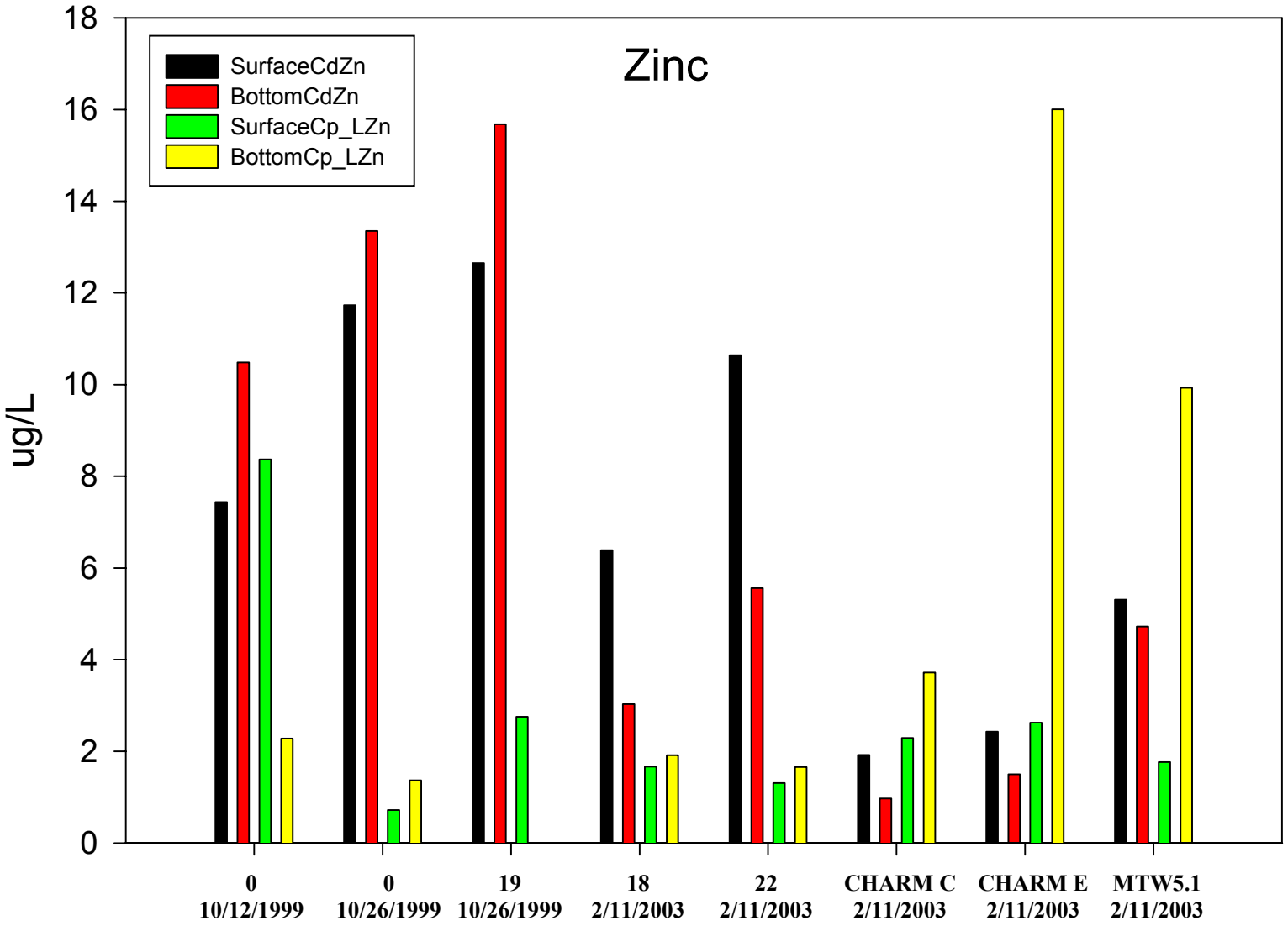

Lead
SurfaceCdPb
BottomCdPb
SurfaceCp_LPb
BottomCp_LPb
ug/L
4
3
2
1
0
18
22
CHARM_C
CHARM_E
MTW5.1

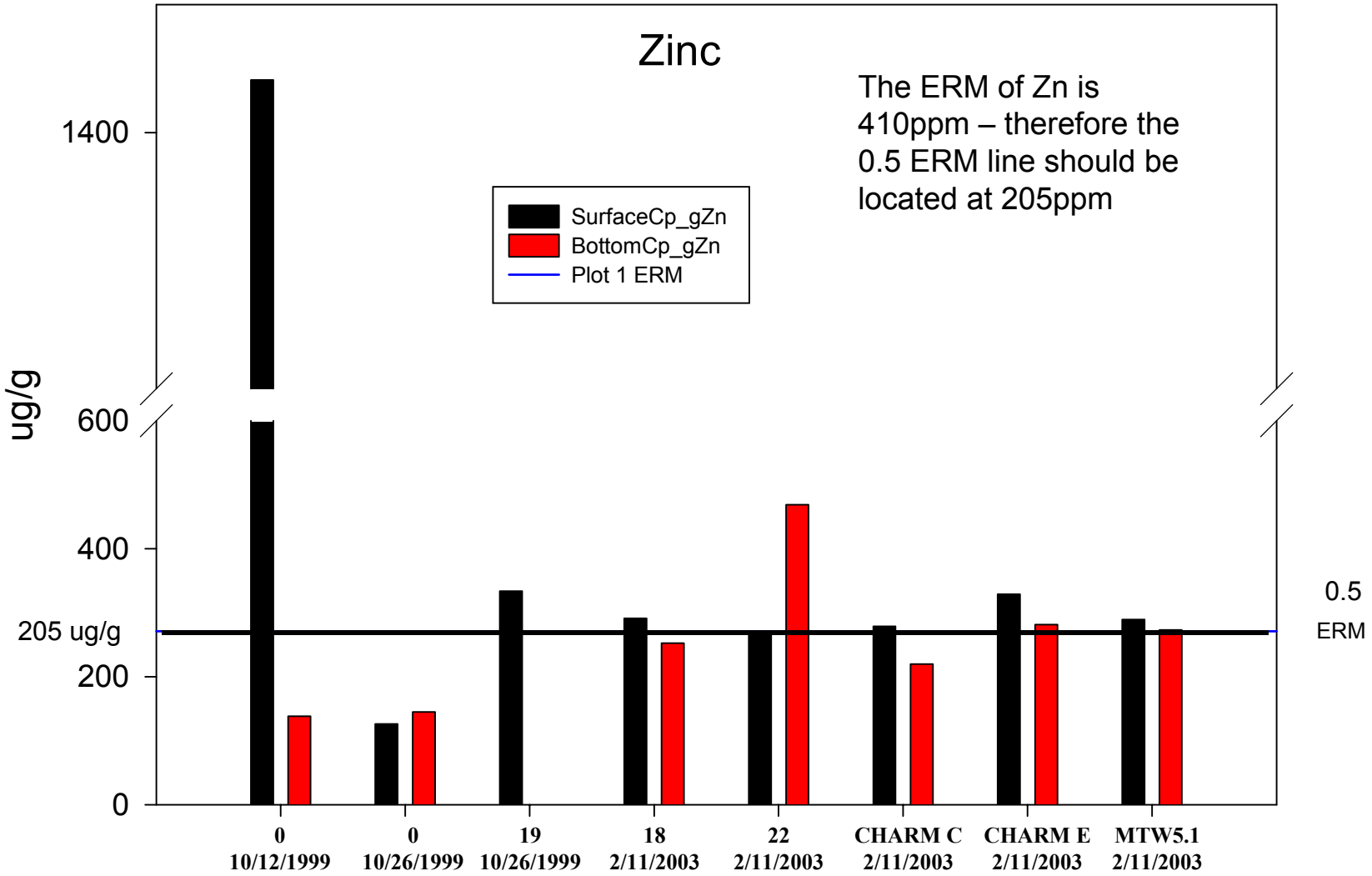

TSP
SurfaceTSP
BottomTSP
mg/L
60
50
40
30
20
10
0
0
10/12/1999
0
10/26/1999
19
10/26/1999
18
2/11/2003
22
2/11/2003
CHARM C
2/11/2003
CHARM E
2/11/2003
MTW5.1
2/11/2003

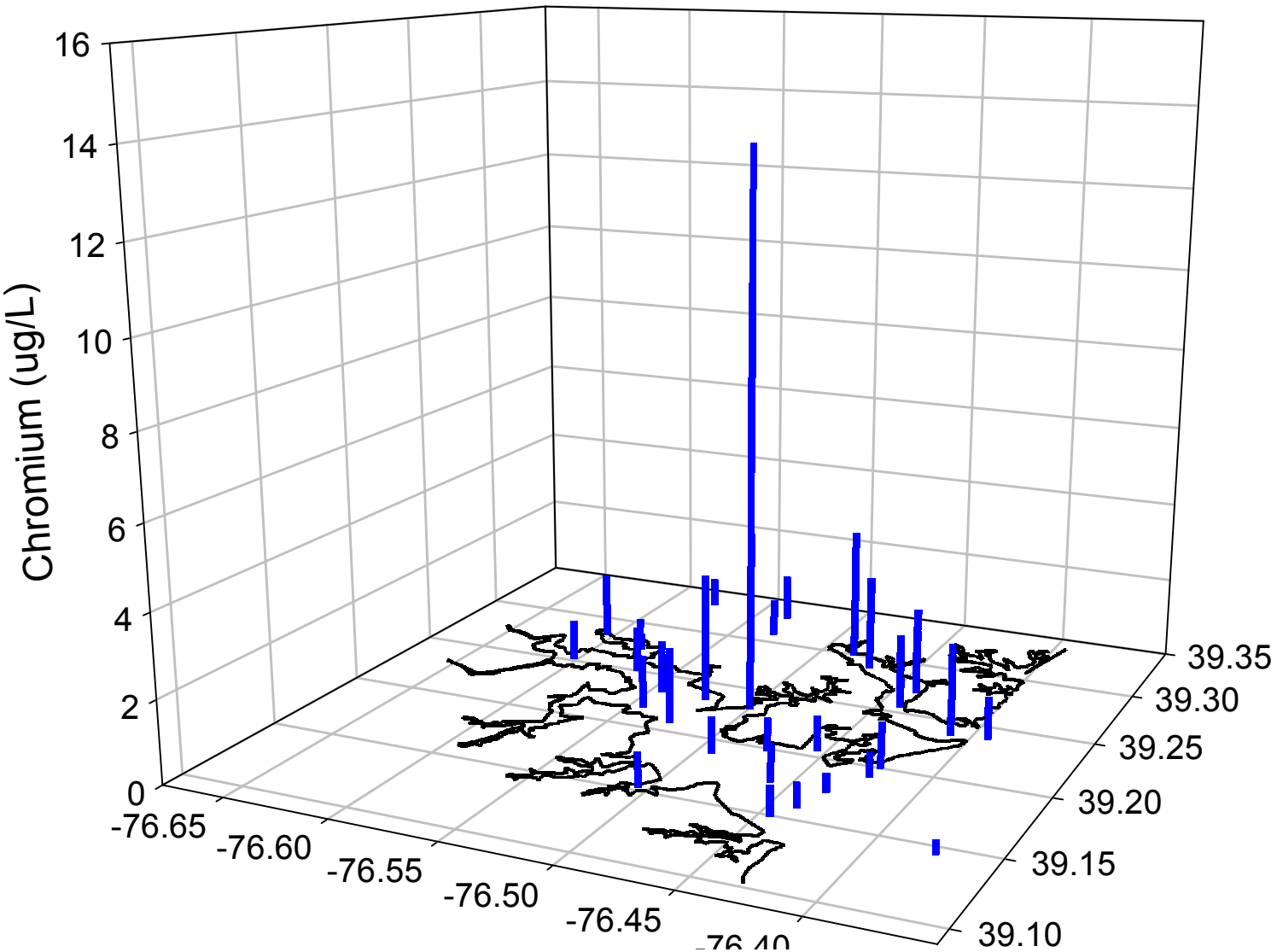

Lead
SurfaceCp_gPb
BottomCp_gPb
Plot 1 EM
ug/g
120
109
100
80
60
40
20
0
0.5
ERM
18
22
CHARM_C
CHARM_E
MTW5.1

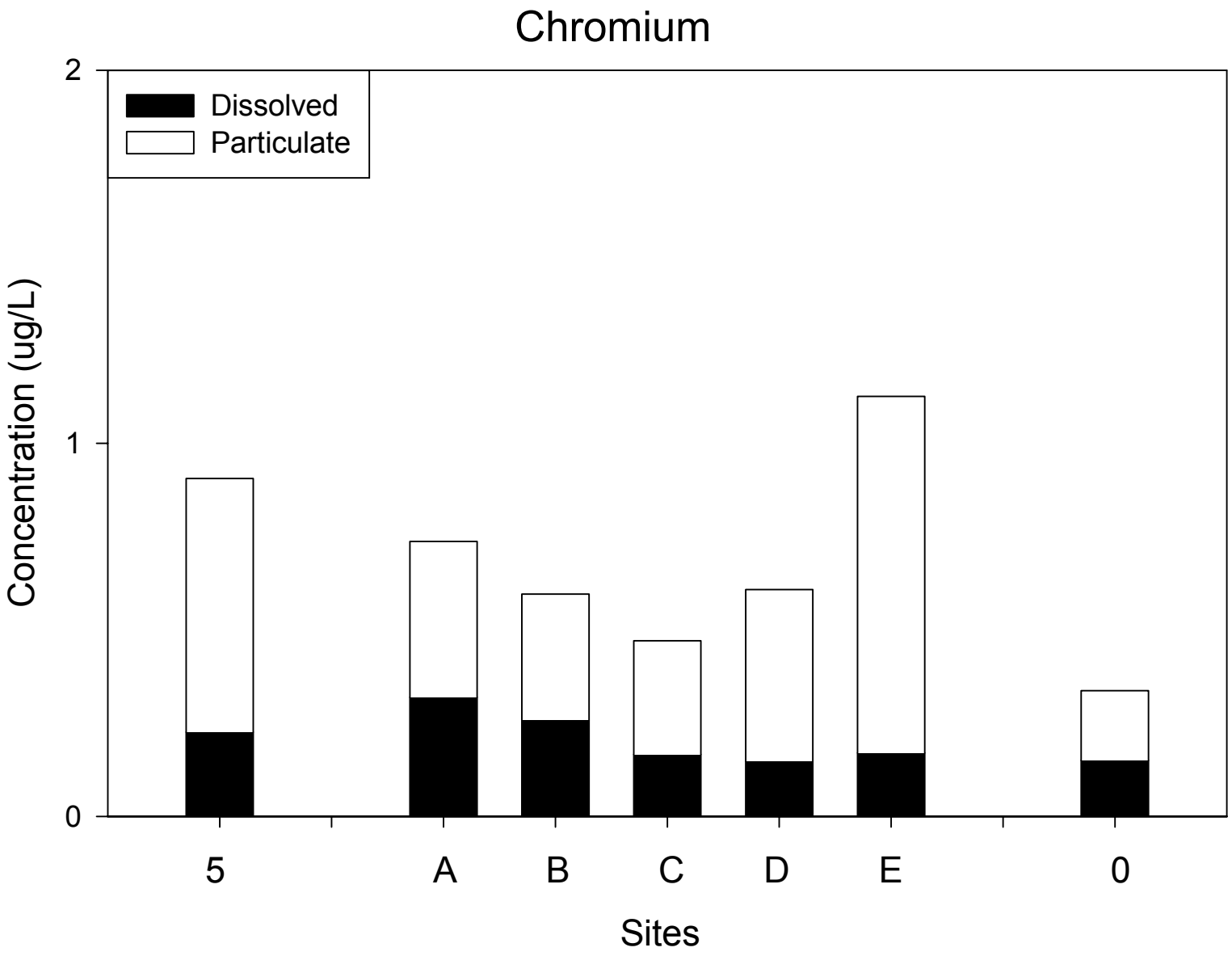

Zinc (ug/L)
50
40
30
20
10
0
-76.7
-76.6
-76.5
39.40
39.35
39.30
39.25
39.20
39.15
39.10

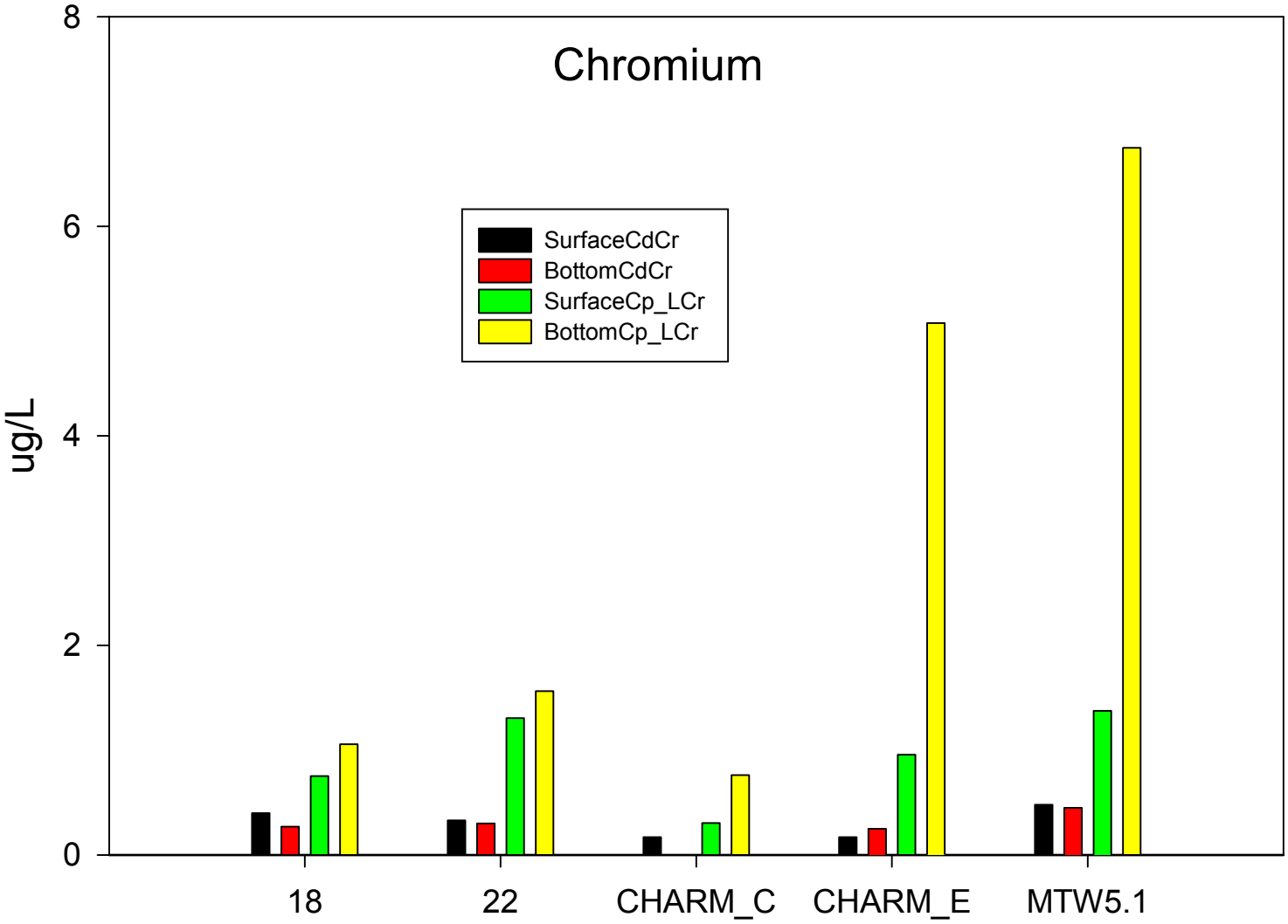

Zinc
Dissolved
Particulate
Concentration (ug/L)
0
1
2
3
4
5
6
5
A
B
C
D
E
0
Sites

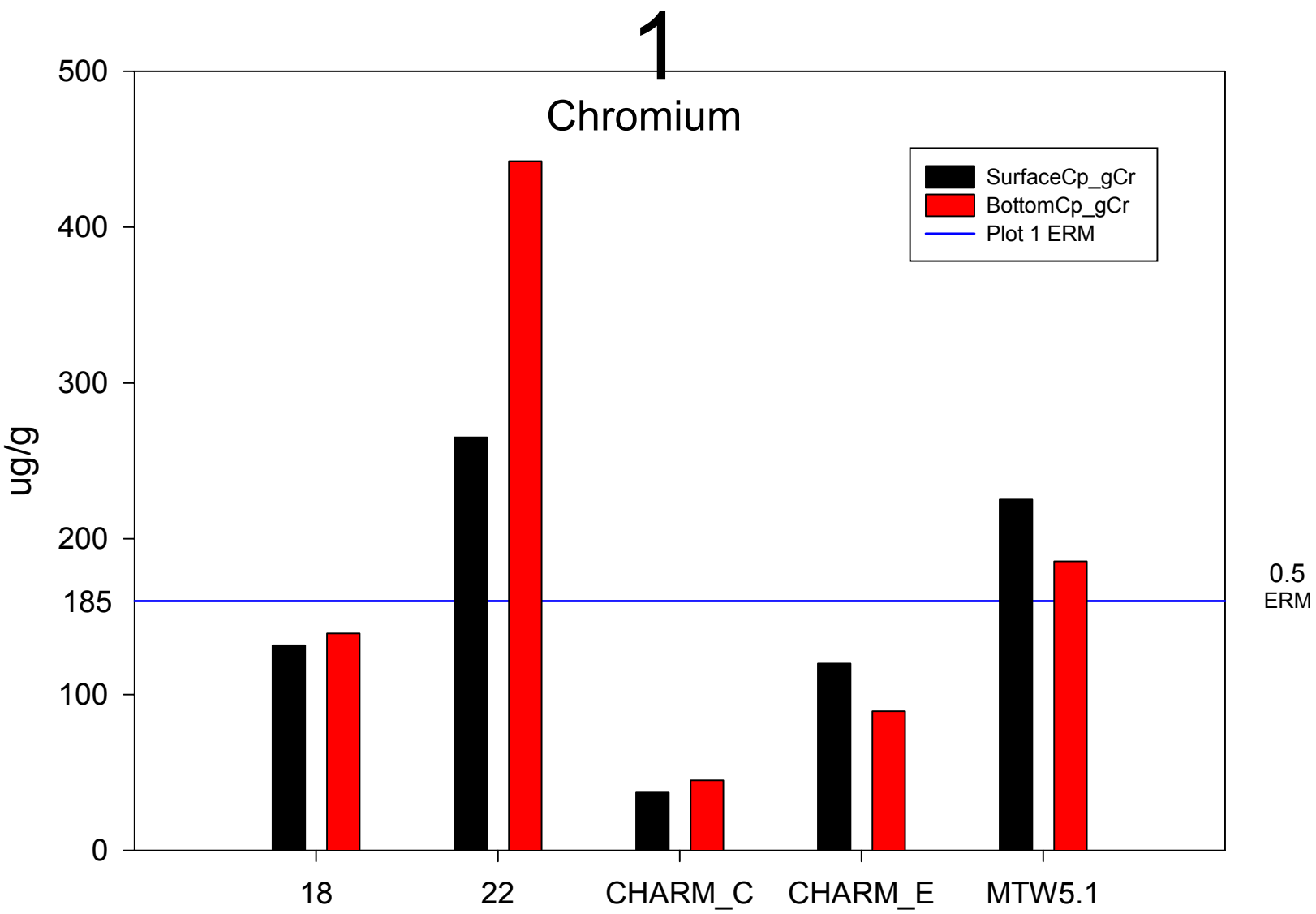

Zinc
SurfaceCdZn
BottomCdZn
SurfaceCp_LZn
BottomCp_LZn
ug/L
18
16
14
12
10
8
6
4
2
0
0
10/12/1999
0
10/26/1999
19
10/26/1999
18
2/11/2003
22
2/11/2003
CHARM C
2/11/2003
CHARM E
2/11/2003
MTW5.1
2/11/2003


Zinc
The ERM of Zn is 410ppm – therefore the 0.5 ERM line should be located at 205ppm
SurfaceCp_gZn
BottomCp_gZn
Plot 1 ERM
ug/g
1400
600
400
205 ug/g
200
0
0.5
ERM
0
10/12/1999
0
10/26/1999
19
10/26/1999
18
2/11/2003
22
2/11/2003
CHARM C
2/11/2003
CHARM E
2/11/2003
MTW5.1
2/11/2003

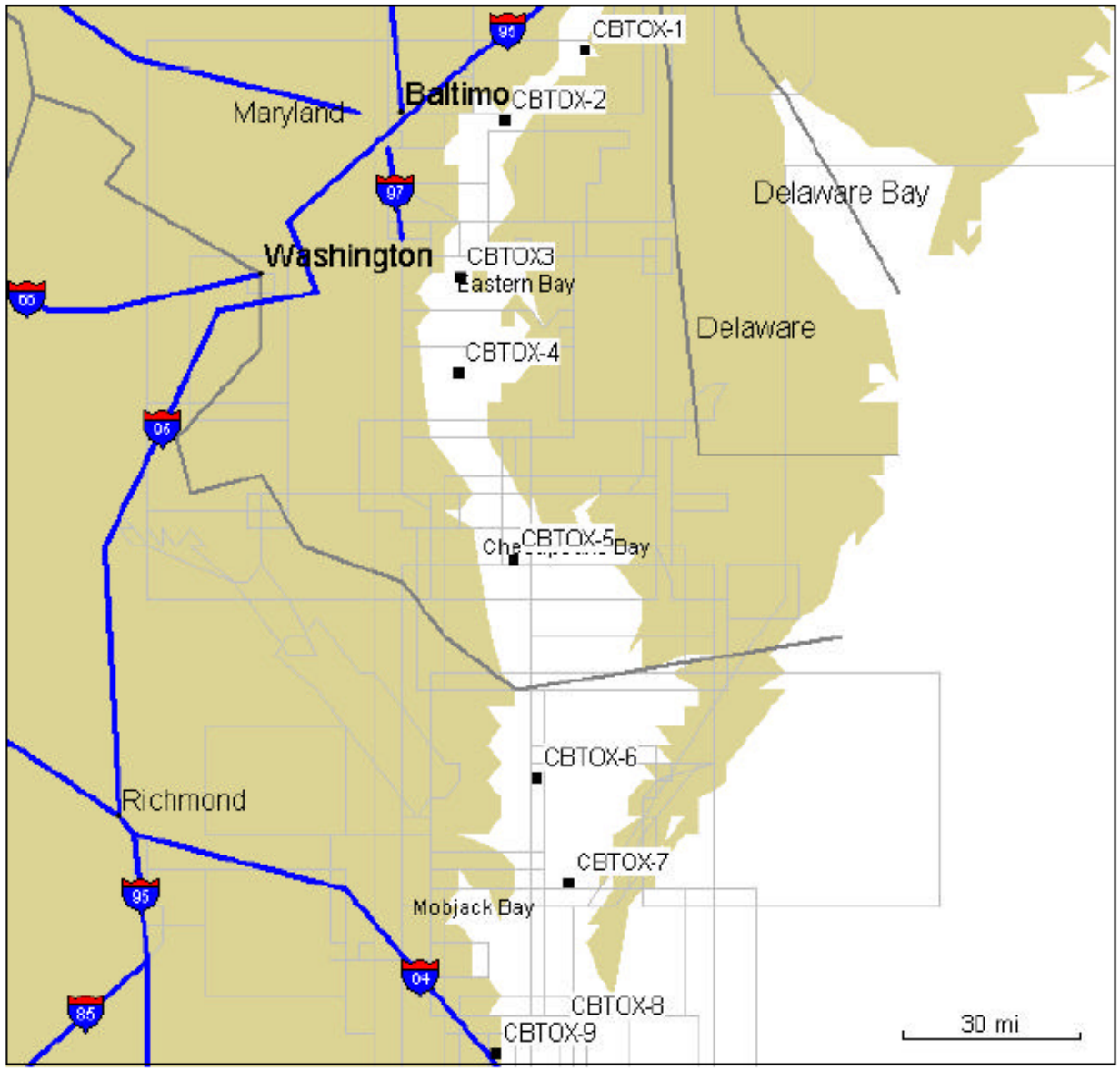

Chromium (ug/L)
16
14
12
10
8
6
4
2
0
-76.65
-76.60
-76.55
-76.50
-76.45
39.35
39.30
39.25
39.20
39.15
39.10


Chromium
Dissolved
Particulate
Concentration (ug/L)
2
1
0
5
A
B
C
D
E
0
Sites

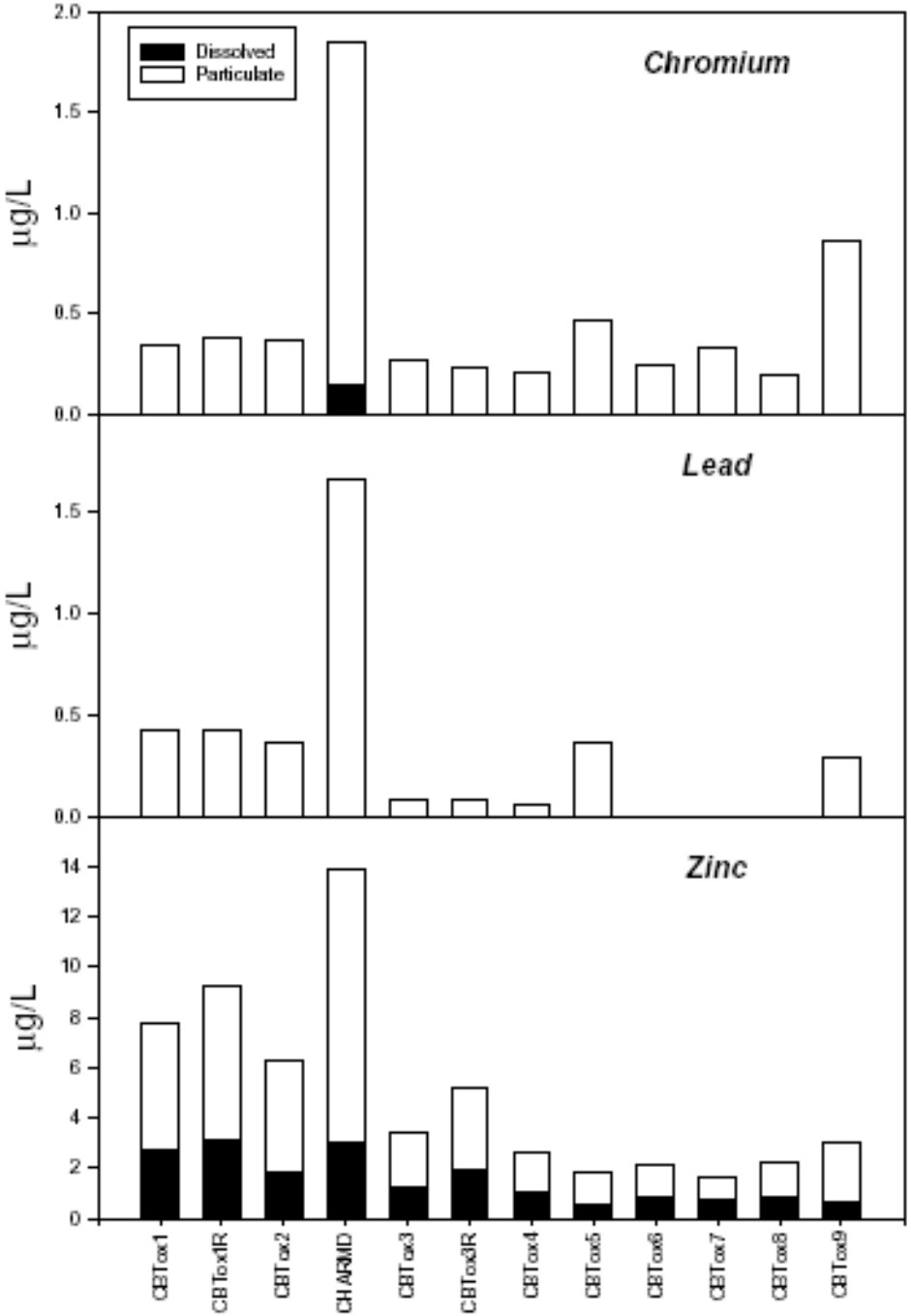

Chromium
SurfaceCdCr
BottomCdCr
SurfaceCp_LCr
BottomCp_LCr
ug/L
8
6
4
2
0
18
22
CHARM_C
CHARM_E
MTW5.1


1
Chromium
SurfaceCp_gCr
BottomCp_gCr
Plot 1 ERM
ug/g
500
400
300
200
185
100
0
0.5
ERM
18
22
CHARM_C
CHARM_E
MTW5.1

February 2003 Chesapeake Bay Metals Survey

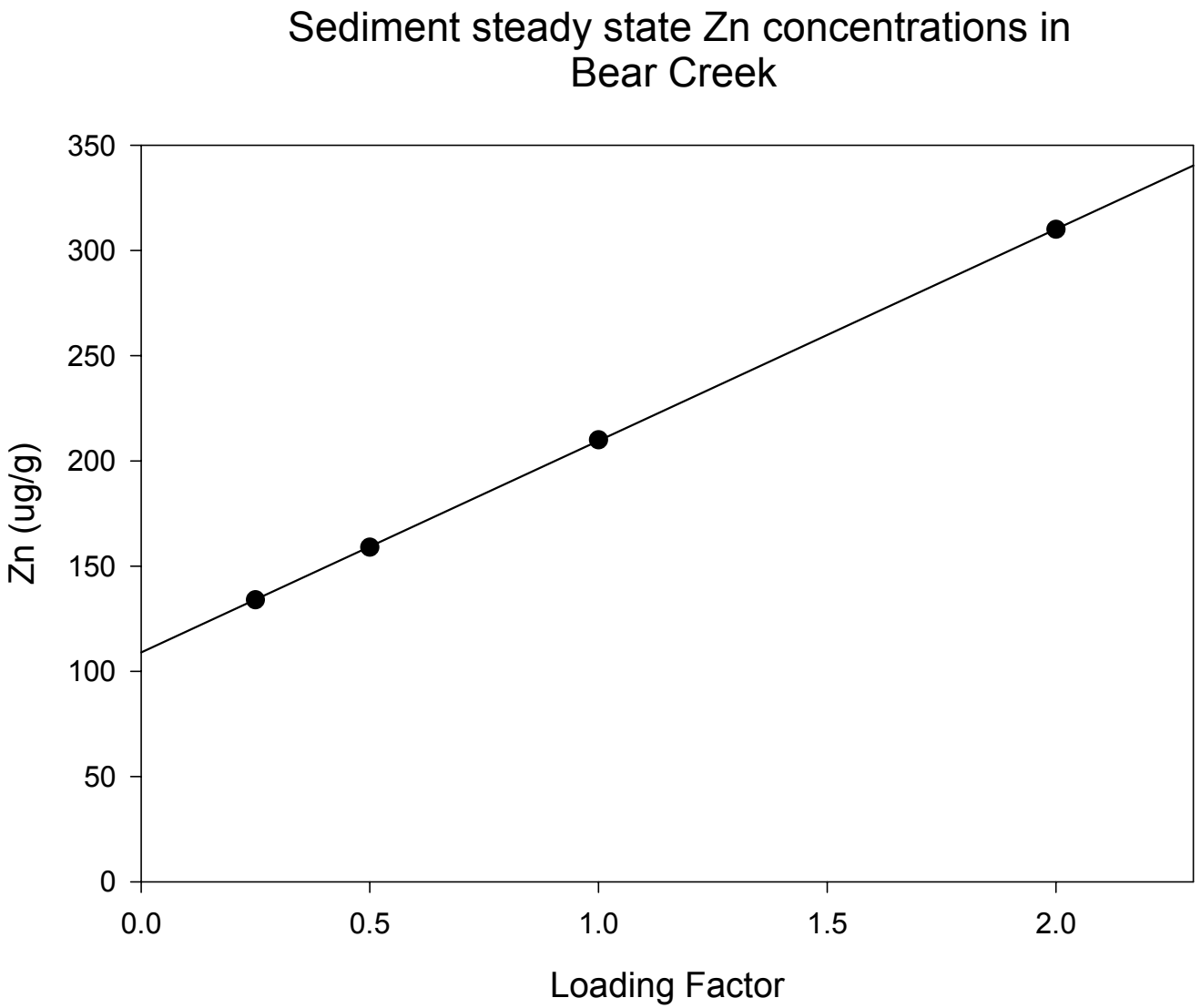


Chesapeake Bay Mainstem Surface Waters, February 20, 2003

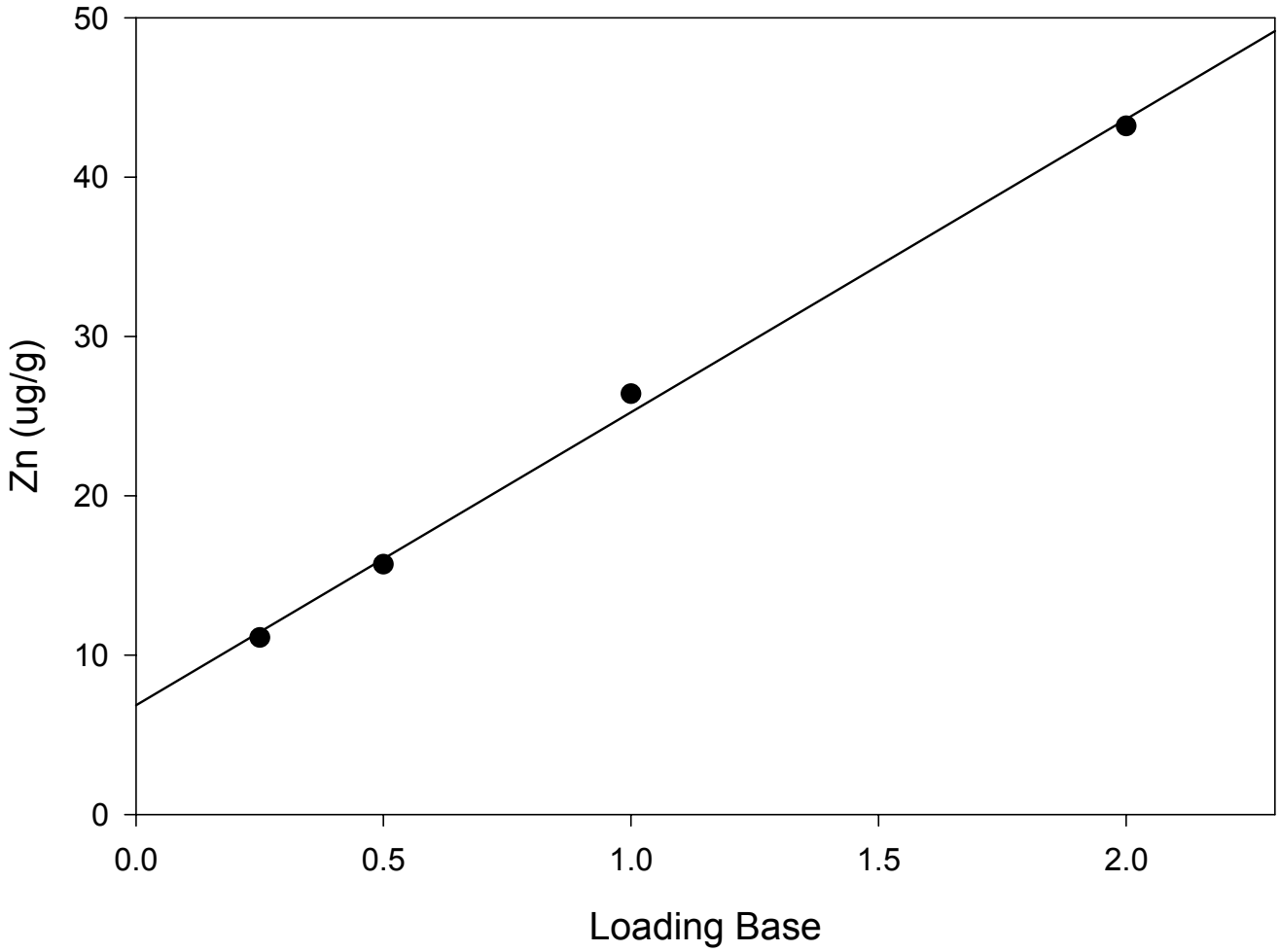


Model Responses

- Relationship between loadings and steady-state metal concentrations in sediments
- Time to steady-state metal concentrations in surficial sediments
- Relative importance of source types

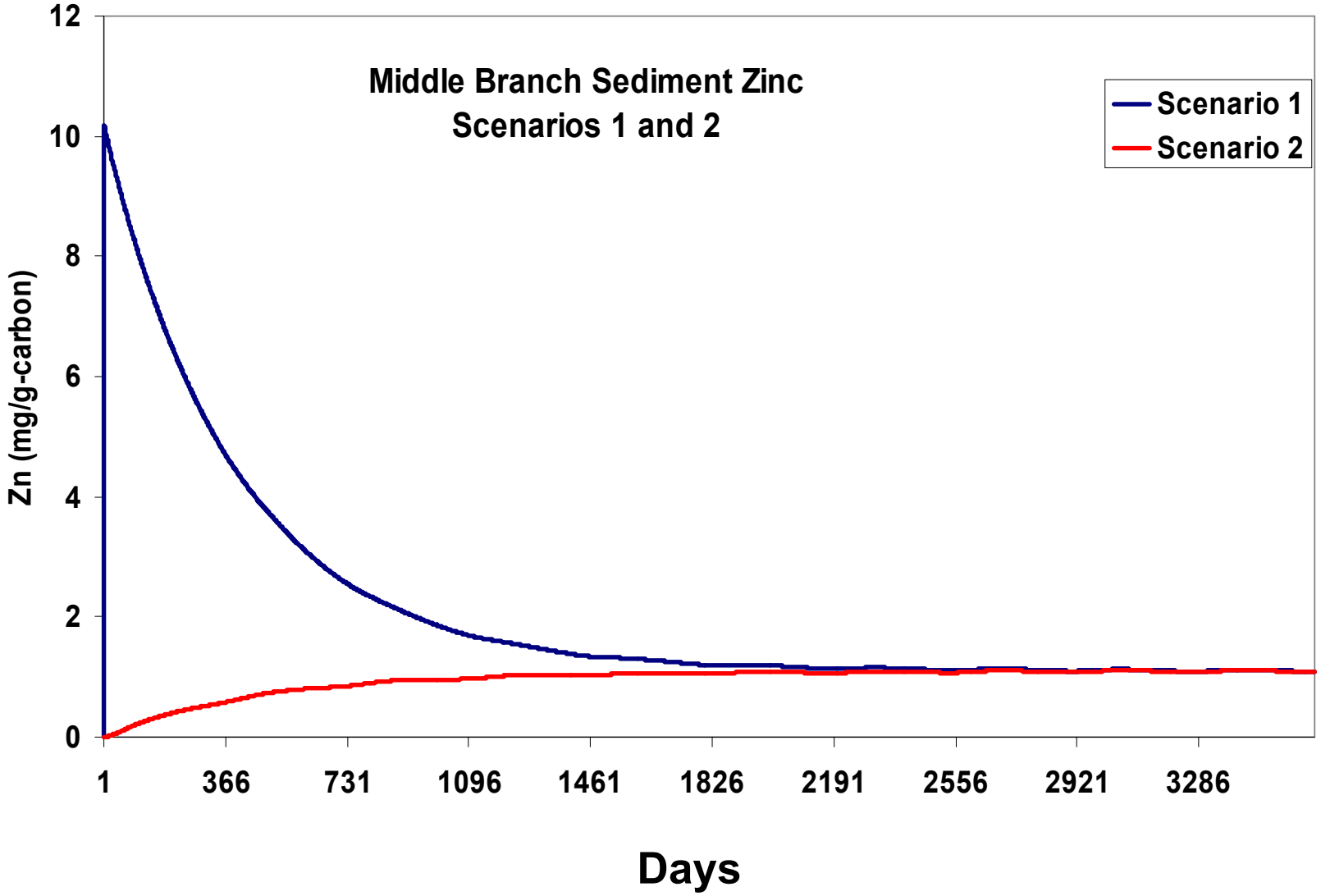

Sediment steady state Zn concentrations in Bear Creek
Zn (ug/g)
350
300
250
200
150
100
50
0
0.0
0.5
1.0
1.5
2.0
Loading Factor

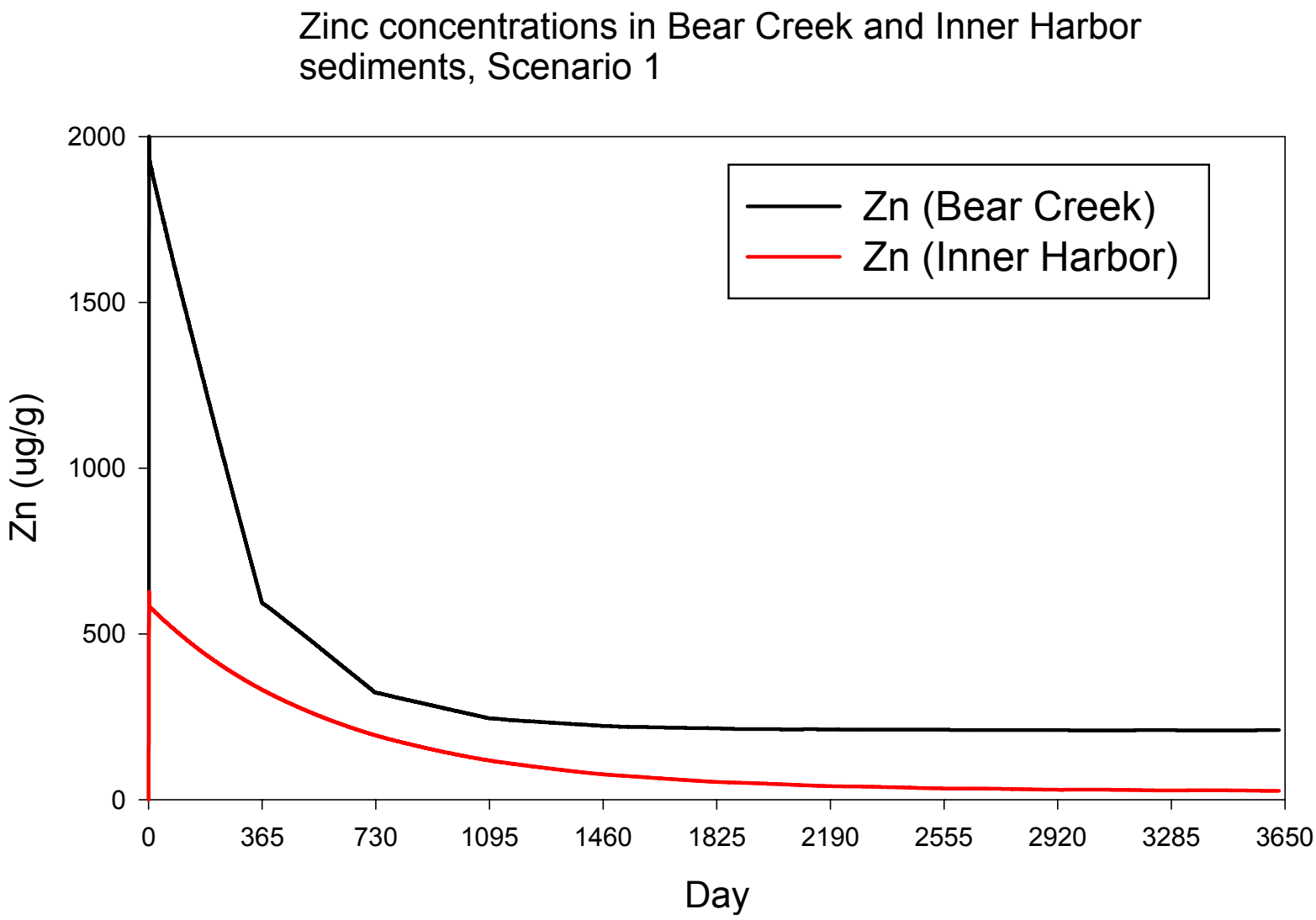
Sediment steady state Zn concentrations in the Inner Harbor

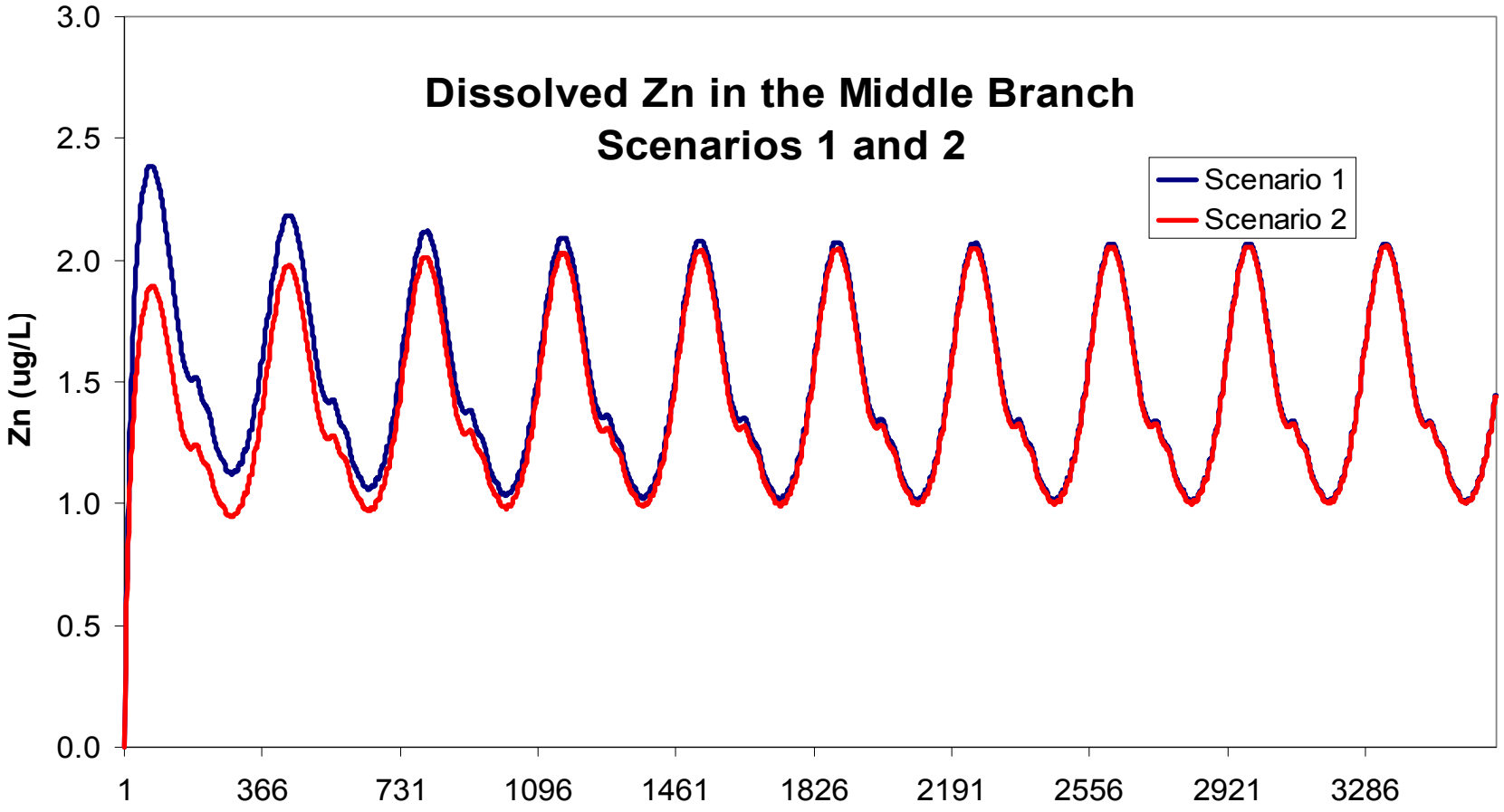


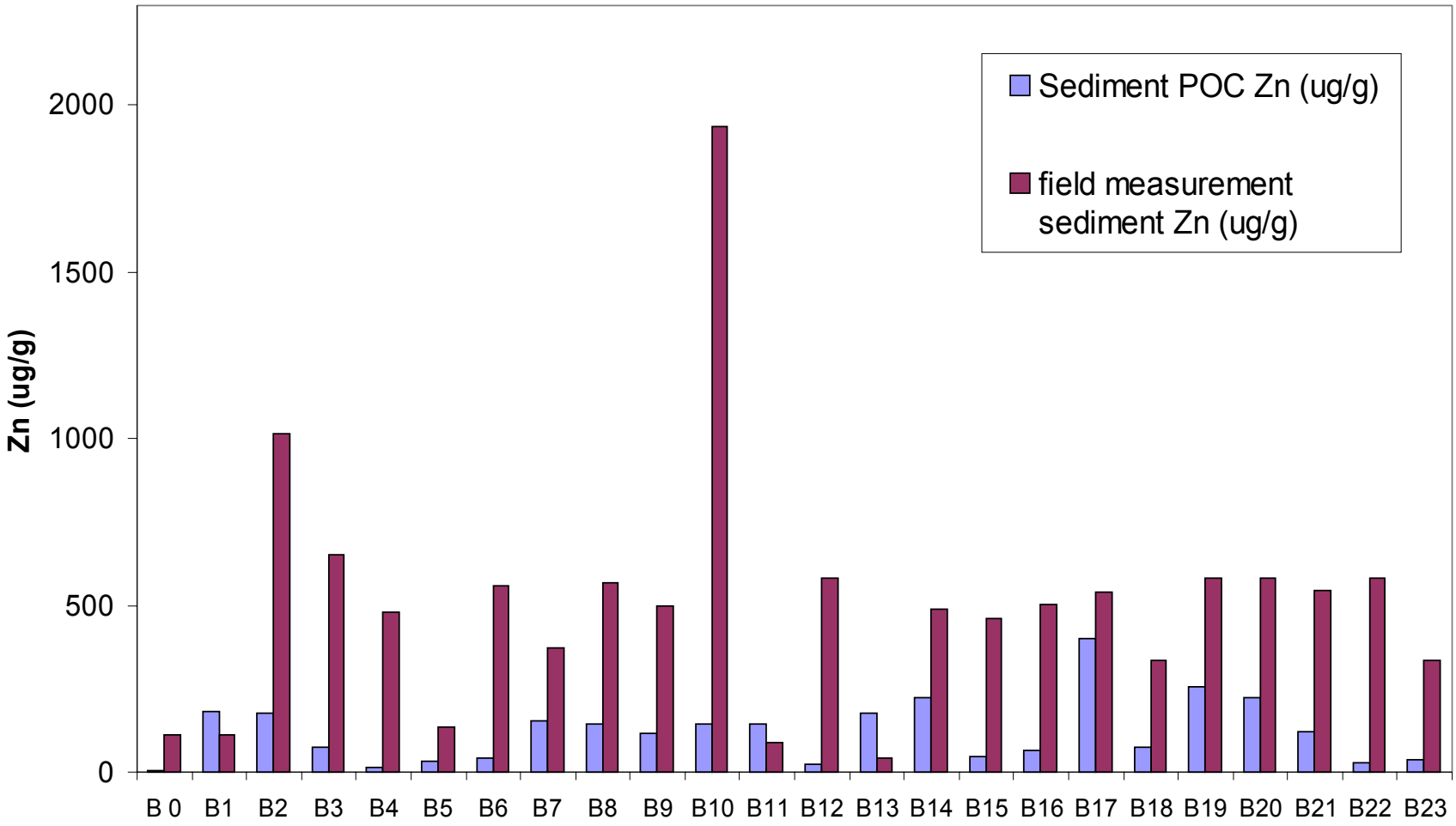
Metal Scenarios

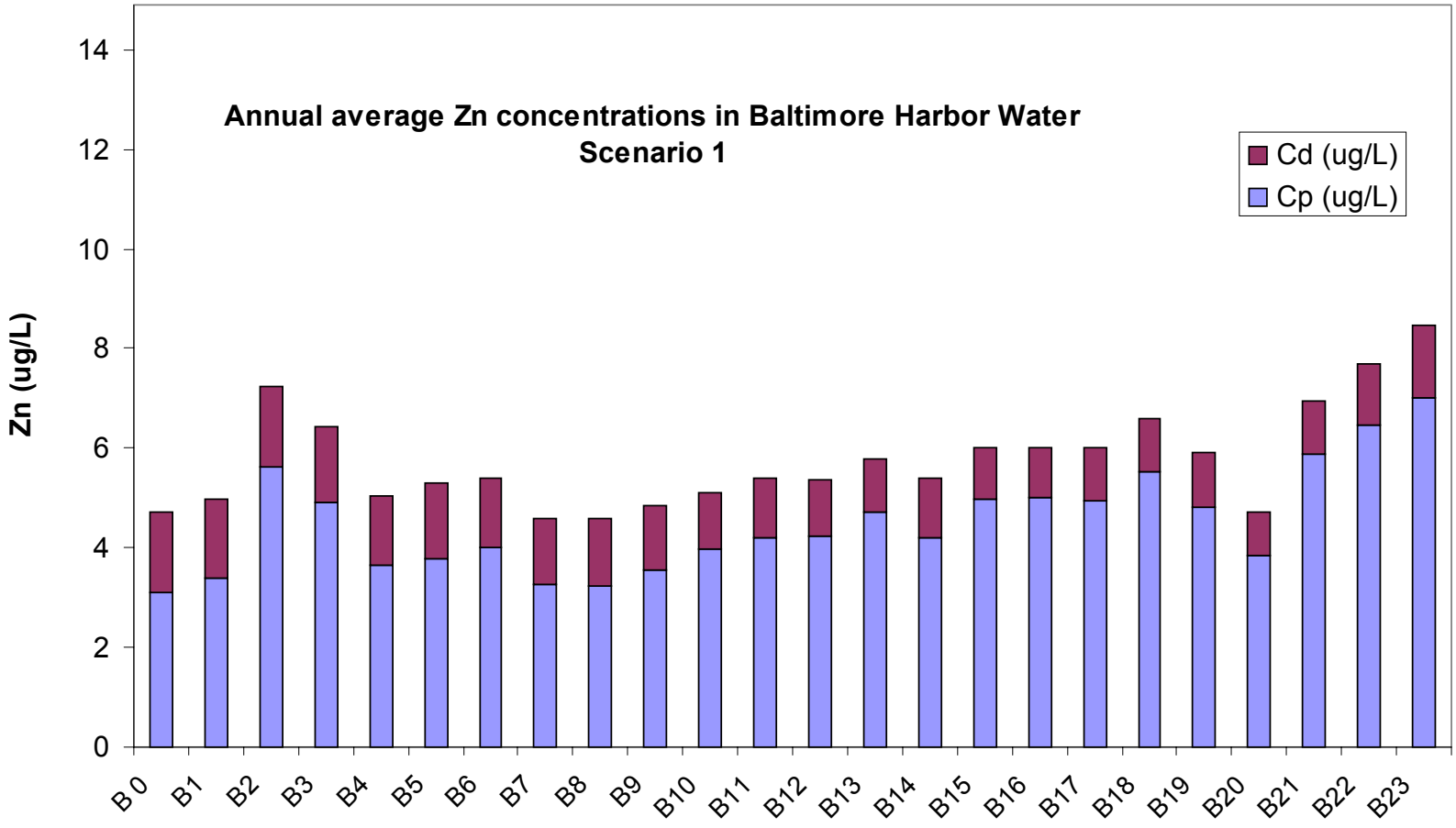
- Scenario 1
  - BSM concentration in sediments
  - MDE point and non-point loadings
  - New harbor mouth boundary conditions
  - CHARM02 transport
- Scenario 2
  - Same as #1, except clean sediments initially
- Scenario 3
  - Same as #1, except no point and non-point loadings

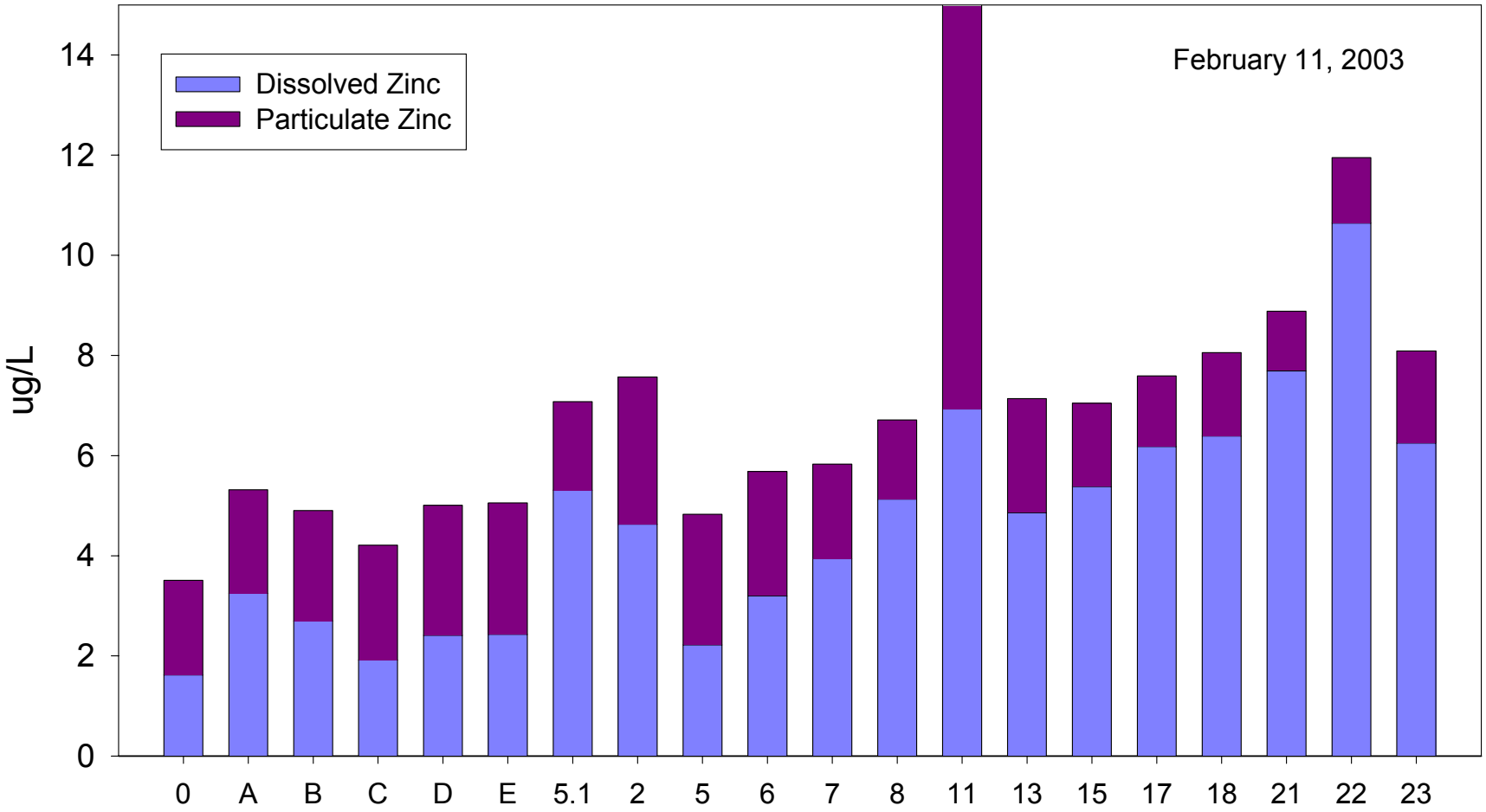

Middle Branch Sediment Zinc
Scenarios 1 and 2
Scenario 1
Scenario 2
Zn (mg/g-carbon)
12
10
8
6
4
2
0
1
366
731
1096
1461
1826
2191
2556
2921
3286
Days


Zinc concentrations in Bear Creek and Inner Harbor sediments, Scenario 1
Zn (Bear Creek)
Zn (Inner Harbor)
Zn (ug/g)
2000
1500
1000
500
0
0
365
730
1095
1460
1825
2190
2555
2920
3285
3650
Day


Dissolved Zn in the Middle Branch
Scenarios 1 and 2
Scenario 1
Scenario 2
Zn (ug/L)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
366
731
1096
1461
1826
2191
2556
2921
3286


Sediment POC Zn (ug/g)
field measurement sediment Zn (ug/g)
Zn (ug/g)
2000
1500
1000
500
0
B 0
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
B15
B16
B17
B18
B19
B20
B21
B22
B23


Annual average Zn concentrations in Baltimore Harbor Water
Scenario 1
Cd (ug/L)
Cp (ug/L)
Zn (ug/L)
0
2
4
6
8
10
12
14
B 0
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
B15
B16
B17
B18
B19
B20
B21
B22
B23


Dissolved Zinc
Particulate Zinc
February 11, 2003
ug/L
0
2
4
6
8
10
12
14
0
A
B
C
D
E
5.1
2
5
6
7
8
11
13
15
17
18
21
22
23

Observations

- Recently measured concentrations of zinc, lead, and chromium in Baltimore Harbor surface waters are below ambient water quality criteria

- Metals concentrations in the particulate phase are relatively higher in bottom waters due to enhanced suspended solids concentrations

- Zinc levels in Baltimore Harbor surface waters are comparable to those in the northern mainstem Chesapeake Bay

Observations

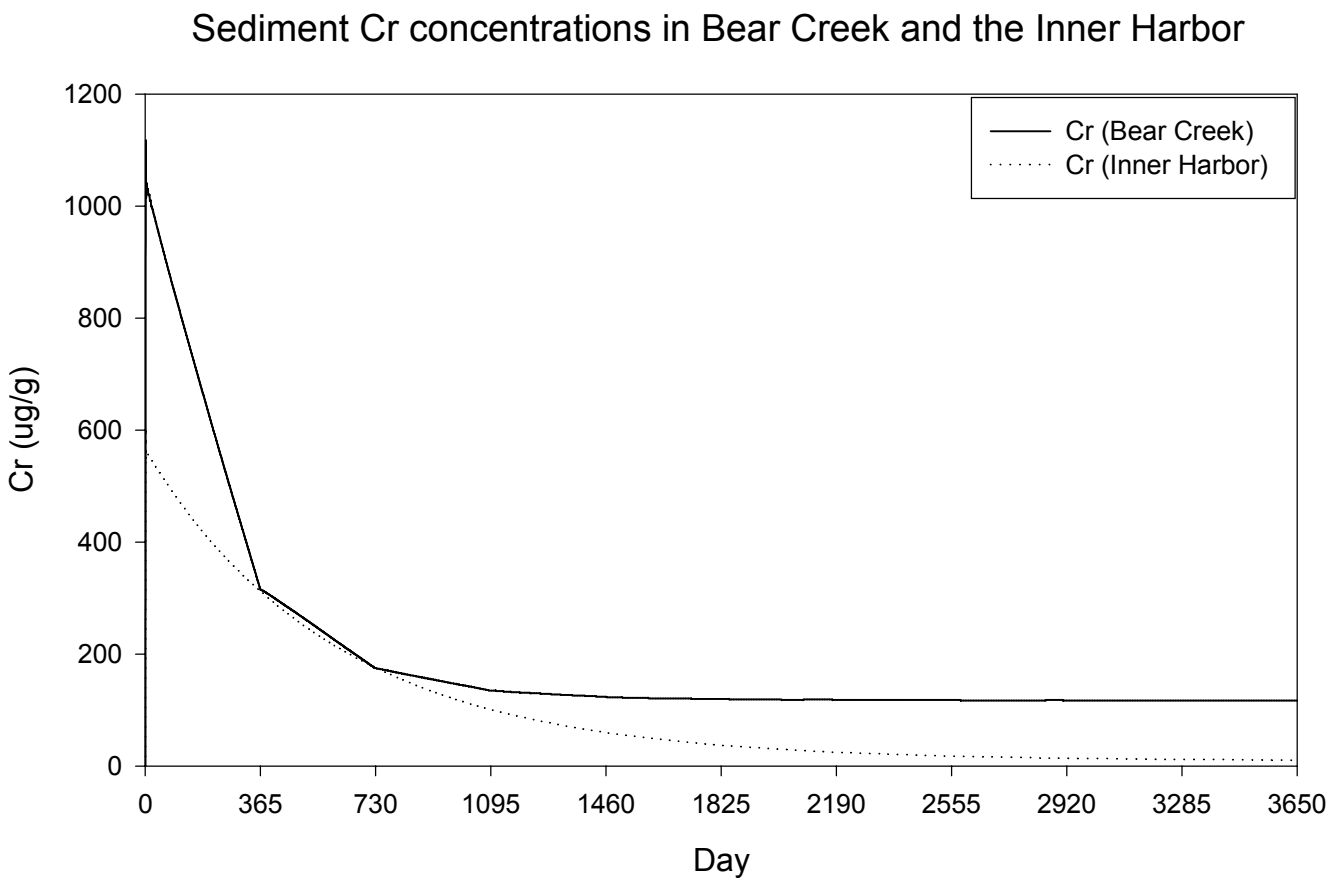
- Under the best current external loadings estimates, concentrations of metals in sediments are predicted to decline without further load reduction.

- Predicted declines are supported by concentrations of metals on suspended particles measured in the February 2003 survey. Those concentrations are often less than those in surface sediment (BSM data) and less than ERM. The 'new' solids contributing to sediments are cleaner than existing sediments and cleaner than assessment thresholds.

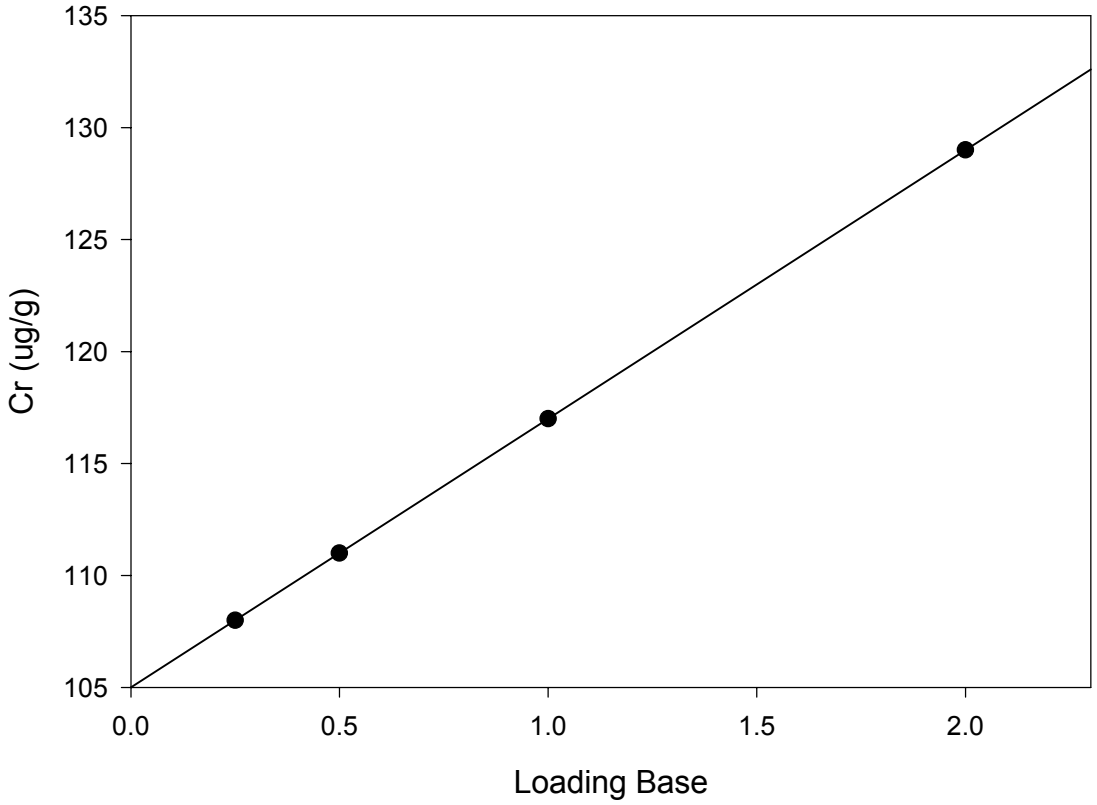
- The model predict steady-state water column metals concentrations that are quite similar to those measured in February 2003, without substantial calibration. The CHARM model predicts that water column metals concentrations respond to changes in loadings fairly quickly (1-2 years). This suggests that present day metal concentrations in the water column mostly reflect current day external loads. The sediment metal concentrations are not solely supported by present day external loads, but rather result from prior loadings.

Next Steps

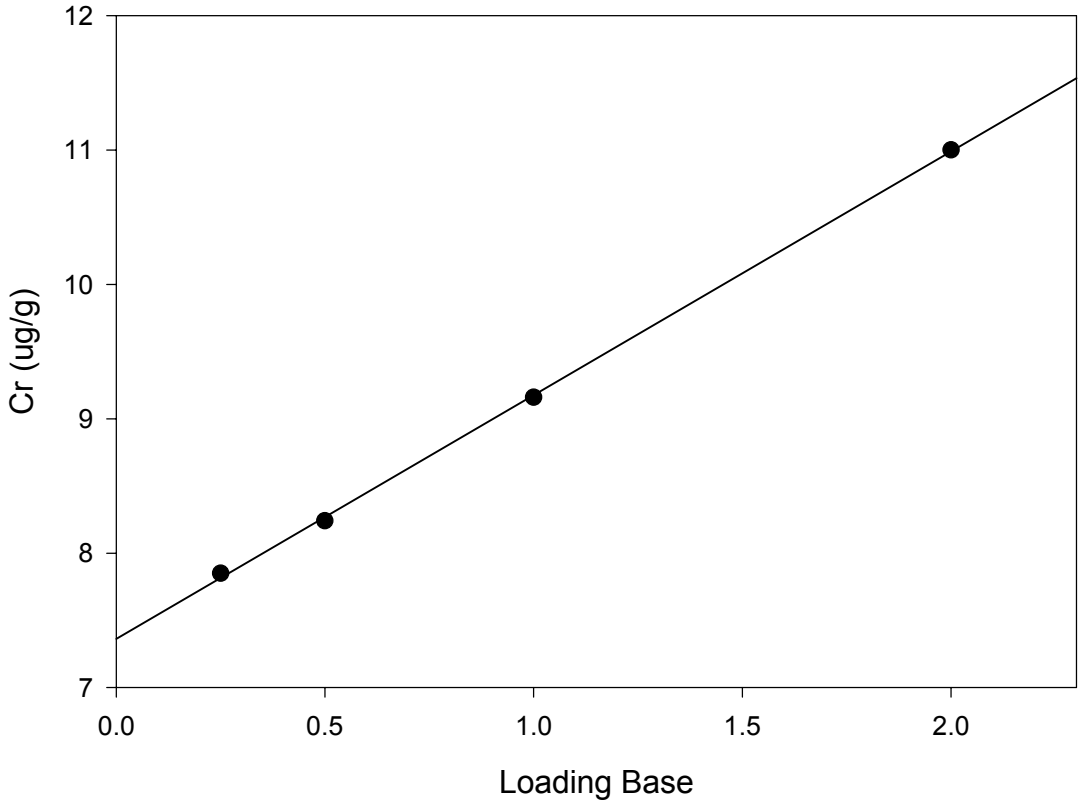
- Short term
  - Comparison of CHARM and VIMS models
  - Investigate response times
  - Metal speciation modeling
- Longer term
  - Additional field measurements to evaluate long-term projections

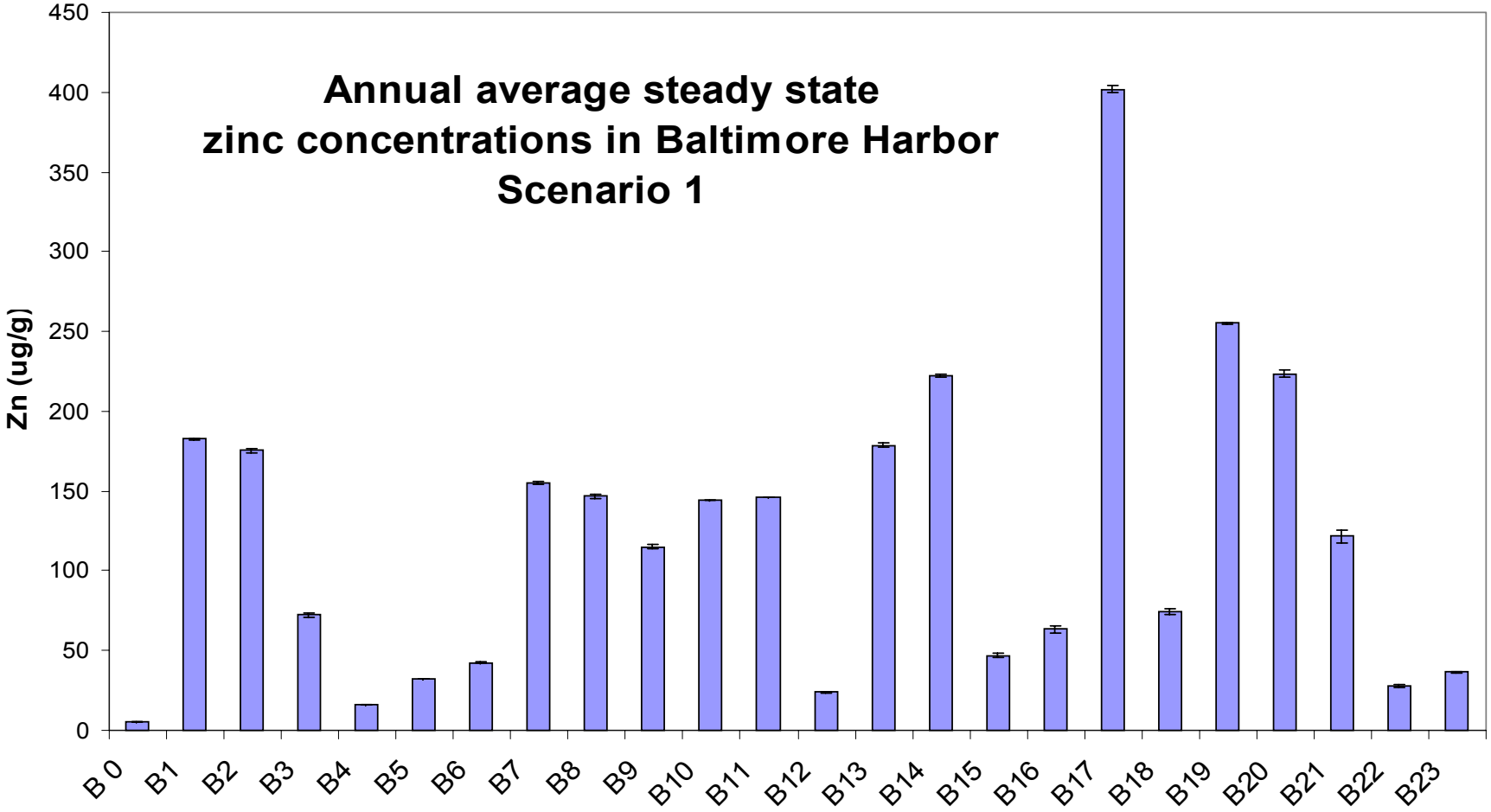

Sediment Cr concentrations in Bear Creek and the Inner Harbor
Cr (Bear Creek)
Cr (Inner Harbor)
Cr (ug/g)
1200
1000
800
600
400
200
0
0
365
730
1095
1460
1825
2190
2555
2920
3285
3650
Day

The sediment steady state Cr concentrations at Bear Creek with different loading runs.
R=0.99
S.S.= 105+12 Loading Base



The sediment steady state Cr concentrations at Inner Harbor with different loading runs.
R=0.99
S.S.=7.36+1.81Loading Base




Annual average steady state
zinc concentrations in Baltimore Harbor
Scenario 1
Zn (ug/g)
450
400
350
300
250
200
150
100
50
0
B 0
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
B15
B16
B17
B18
B19
B20
B21
B22
B23